General

Guideline Title

ESC guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation.

Bibliographic Source(s)

Task Force on the management of ST-segment elevation acute myocardial infarction of the ESC, Steg PG, James SK, Atar D, Badano LP, Blomstrom-Lundqvist C, Borger MA, Di Mario C, Dickstein K, Ducrocq G, Fernandez-Aviles F, Gershlick AH, Giannuzzi P, Halvorsen S, Huber K, Juni P, Kastrati A, Knuuti J, Lenzen MJ, Mahaffey KW, Valgimigli M, van't Hof A, Widimsky P, Zahger D. ESC guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. Eur Heart J. 2012 Oct;33(20):2569-619. [346 references] PubMed

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Van de Werf F, Bax J, Betriu A, Blomstrom-Lundqvist C, Crea F, Falk V, Filippatos G, Fox K, Huber K, Kastrati A, Rosengren A, Steg PG, Tubaro M, Verheugt F, Weidinger F, Weis M, ESC Committee for Practice Guidelines (CPG), Vahanian A, Camm J, De Caterina R, Dean V, Dickstein K, Funck-Brentano C, Hellemans I, Kristensen SD, McGregor K, Sechtem U, Silber S, Tendera M, Widimsky P, Zamorano JL. Management of acute myocardial infarction in patients presenting with persistent ST-segment elevation: the Task Force on the Management of ST-Segment Elevation Acute Myocardial Infarction of the European Society of Cardiology. Eur Heart J 2008 Dec;29(23):2909-45.

Regulatory Alert

FDA Warning/Regulatory Alert

Note from the National Guideline Clearinghouse: This guideline references a drug(s) for which important revised regulatory and/or warning information has been released.

- March 22, 2016 – Opioid pain medicines [   ]: The U.S. Food and Drug Administration (FDA) is warning about several safety issues with the entire class of opioid pain medicines. These safety risks are potentially harmful interactions with numerous other medications, problems with the adrenal glands, and decreased sex hormone levels. They are requiring changes to the labels of all opioid drugs to warn about these risks.

Recommendations

Major Recommendations

The class of recommendations (I-III) and levels of evidence (A-C) are defined at the end of the "Major Recommendations" field.

<u>Emergency Care</u>

Initial Diagnosis

Recommendations for Initial Diagnosis

A 12-lead electrocardiogram (ECG) must be obtained as soon as possible at the point of first medical contact (FMC), with a target delay of ≤10 min. (Class of recommendation I, level of evidence B) (Diercks et al., 2006; Rokos et al., 2009)

ECG monitoring must be initiated as soon as possible in all patients with suspected ST-segment elevation myocardial infarction (STEMI). (Class of recommendation I, level of evidence B) (O'Doherty et al., 1983; Mehta et al., 2009)

Blood sampling for serum markers is recommended routinely in the acute phase but one should not wait for the results before initiating reperfusion treatment. (Class of recommendation I, level of evidence C)

The use of additional posterior chest wall leads (V_7–V_9 ≥0.05 mV) in patients with high suspicion of inferobasal myocardial infarction (circumflex occlusion) should be considered. (Class of recommendation IIa, level of evidence C)

Echocardiography may assist in making the diagnosis in uncertain cases but should not delay transfer for angiography. (Class of recommendation IIb, level of evidence C)

Relief of Pain, Breathlessness and Anxiety

Recommendations for Relief of Pain, Breathlessness and Anxiety

Titrated intravenous (i.v.) opioids are indicated to relieve pain. (Class of recommendation I, level of evidence C)

Oxygen is indicated in patients with hypoxia (saturated oxygen [SaO_2] <95%), breathlessness, or acute heart failure. (Class of recommendation I, level of evidence C)

Tranquillizer may be considered in very anxious patients. (Class of recommendation IIa, level of evidence C)

Cardiac Arrest

Recommendations for Cardiac Arrest

All medical and paramedical personnel caring for a patient with suspected myocardial infarction must have access to defibrillation equipment and be trained in cardiac life support. (Class of recommendation I, level of evidence C)

It is recommended to initiate ECG monitoring at the point of FMC in all patients with suspected myocardial infarction. (Class of recommendation I, level of evidence C)

Therapeutic hypothermia is indicated early after resuscitation of cardiac arrest patients who are comatose or in deep sedation. (Class of recommendation I, level of evidence B) (Bernard et al., 2002; Hypothermia after Cardiac Arrest Study Group, 2002; Belliard et al., 2007)

Immediate angiography with a view to primary percutaneous coronary intervention (PCI) is recommended in patients with resuscitated cardiac arrest whose ECG shows STEMI. (Class of recommendation I, level of evidence B) (Spaulding et al., 1997; Kern & Rahman, 2010; Garot et al., 2007)

Immediate angiography with a view to primary PCI should be considered in survivors of cardiac arrest without diagnostic ECG ST-segment elevation but with a high suspicion of ongoing infarction. (Class of recommendation IIa, level of evidence B) (Spaulding et al., 1997; Garot et al., 2007)

Pre-hospital Logistics of Care

Recommendations for Logistics of Pre-hospital Care

Ambulance teams must be trained and equipped to identify STEMI (with use of ECG recorders and telemetry as necessary) and administer initial

therapy, including thrombolysis where applicable. (Class of recommendation I, level of evidence B) (Welsh et al., 2005)

The prehospital management of STEMI patients must be based on regional networks designed to deliver reperfusion therapy expeditiously and effectively, with efforts made to make primary PCI available to as many patients as possible. (Class of recommendation I, level of evidence B) (Kalla et al., 2006)

Primary PCI-capable centres must deliver a 24/7 service and be able to start primary PCI as soon as possible but always within 60 min from the initial call. (Class of recommendation I, level of evidence B) (Widimsky et al., 2010; Knot et al., 2009; Nallamothu et al., 2007)

All hospitals and emergency medical systems (EMSs) participating in the care of patients with STEMI must record and monitor delay times and work to achieve and maintain the following quality targets:

- FMC to first ECG ≤10 min
- FMC to reperfusion therapy
- For fibrinolysis ≤30 min
- For primary PCI ≤90 min (≤60 min if the patient presents within 120 min of symptom onset or directly to a PCI-capable hospital)

(Class of recommendation I, level of evidence B) (Rathore et al., 2009; Nielsen et al., 2011)

All EMSs, emergency departments, and coronary care units must have a written updated STEMI management protocol, preferably shared within geographic networks. (Class of recommendation I, level of evidence C)

Patients presenting to a non-PCI-capable hospital and awaiting transportation for primary or rescue PCI must be attended in an appropriately monitored area. (Class of recommendation I, level of evidence C)

Patients transferred to a PCI-capable centre for primary PCI should bypass the emergency department and be transferred directly to the catheterization laboratory. (Class of recommendation IIa, level of evidence B) (Pinto et al., 2006; Bradley et al., 2006; Steg et al., 2006)

Reperfusion Therapy

Recommendations for Reperfusion Therapy

Reperfusion therapy is indicated in all patients with symptoms of <12 h duration and persistent ST-segment elevation or (presumed) new left bundle branch block (LBBB). (Class of recommendation I, level of evidence A) (Boersma et al., 1996; Boersma & Primary Coronary Angioplasty vs. Thrombolysis Group, 2006)

Reperfusion therapy (preferably primary PCI) is indicated if there is evidence of ongoing ischaemia, even if symptoms may have started >12 h beforehand or if pain and ECG changes have been stuttering. (Class of recommendation I, level of evidence C) (Gierlotka et al., 2011)

Reperfusion therapy with primary PCI may be considered in stable patients presenting 12 to 24 h after symptom onset. (Class of recommendation IIb, level of evidence B) (Schomig et al., 2005; Ndrepepa et al., 2009)

Routine PCI of a totally occluded artery >24 h after symptom onset in stable patients without signs of ischaemia (regardless of whether fibrinolysis was given or not) is not recommended. (Class of recommendation III, level of evidence A) (Hochman et al., 2006; Ioannidis & Katritsis, 2007; Menon et al., 2009)

Primary PCI: Indications and Procedural Aspects

Indications for Primary PCI

Primary PCI is the recommended reperfusion therapy over fibrinolysis if performed by an experienced team within 120 min of FMC. (Class of recommendation I, level of evidence A) (Keeley, Boura, & Grines, 2003; Cucherat, Bonnefoy, & Tremeau, 2003)

Primary PCI is indicated for patients with severe acute heart failure or cardiogenic shock, unless the expected PCI related delay is excessive and the patient presents early after symptom onset. (Class of recommendation I, level of evidence B) (Hochman et al., 1999)

Procedural Aspects of Primary PCI

Stenting is recommended (over balloon angioplasty alone) for primary PCI. (Class of recommendation I, level of evidence A) (Nordmann et al., 2004; Stone et al., 1999)

Primary PCI should be limited to the culprit vessel with the exception of cardiogenic shock and persistent ischaemia after PCI of the supposed

culprit lesion. (Class of recommendation IIa, level of evidence B) (Widimsky & Holmes, 2011; Hannan et al., 2010; Toma et al., 2010; Vlaar et al., 2011)

If performed by an experienced radial operator, radial access should be preferred over femoral access. (Class of recommendation IIa, level of evidence B) (Jolly et al., 2011; Romagnoli et al., 2012)

If the patient has no contraindications to prolonged dual antiplatelet therapy (DAPT) (indication for oral anticoagulation, or estimated high long-term bleeding risk) and is likely to be compliant, drug-eluting stent (DES) should be preferred over bare-metal stent (BMS). (Class of recommendation IIa, level of evidence A) (Kastrati et al., 2007; Stone et al., 2011; Wijnbergen et al., 2012; De Luca et al., 2012)

Routine thrombus aspiration should be considered. (Class of recommendation IIa, level of evidence B) (Svilaas et al., 2008; Vlaar et al., 2008; Burzotta et al., 2009)

Routine use of distal protection devices is not recommended. (Class of recommendation III, level of evidence C) (Bavry, Kumbhani, & Bhatt, 2008; Kelbaek et al., 2008)

Routine use of intra-aortic balloon pump (IABP) (in patients without shock) is not recommended. (Class of recommendation III, level of evidence A) (Patel et al., 2011; Sjauw et al., 2009)

Periprocedural Antithrombotic Medication in Primary Percutaneous Coronary Intervention

Antiplatelet Therapy

Aspirin oral or i.v. (if unable to swallow) is recommended. (Class of recommendation I, level of evidence B) ("Randomised trial,"1988; Patrono et al., 2011)

An adenosine diphosphate (ADP)-receptor blocker is recommended in addition to aspirin. Options are (Class of recommendation I, level of evidence A) (Leon et al., 1998; Schomig et al., 1996):

- Prasugrel in clopidogrel-naive patients, if no history of prior stroke/transient ischaemic attack (TIA), age <75 years (Class of recommendation I, level of evidence B) (Wiviott et al., 2007)
- Ticagrelor (Class of recommendation I, level of evidence B) (Wallentin et al., 2009)
- Clopidogrel, preferably when prasugrel or ticagrelor are either not available or contraindicated (Class of recommendation I, level of evidence C)

Glycoprotein (GP) IIb/IIIa inhibitors should be considered for bailout therapy if there is angiographic evidence of massive thrombus, slow or no-reflow or a thrombotic complication. (Class of recommendation IIa, level of evidence C)

Routine use of a GP IIb/IIIa inhibitor as an adjunct to primary PCI performed with unfractionated heparin may be considered in patients without contraindications. (Class of recommendation IIb, level of evidence B) (De Luca et al., 2005; Zeymer et al., 2010; Akerblom et al., 2010; Van 't Hof et al., 2008; Valgimigli et al., "Tirofiban," 2010)

Upstream use of a GP IIb/IIIa inhibitor (vs. in-lab use) may be considered in high-risk patients undergoing transfer for primary PCI. (Class of recommendation IIb, level of evidence B) (Ellis et al., 2008; Herrmann et al., 2009; De Luca et al., 2005; De Luca et al., 2011)

Options for GP IIb/IIIa inhibitors are (with level of evidence [LoE] for each agent):

- Abciximab (Level of evidence A) (De Luca et al., 2005)
- Eptifibatide (with double bolus) (Level of evidence B) (Zeymer et al., 2010; Akerblom et al., 2010)
- Tirofiban (with a high bolus dose) (Level of evidence B) (Van't Hof et al., 2008; Valgimigli et al., "Tirofiban," 2010)

Anticoagulants

An injectable anticoagulant must be used in primary PCI. (Class of recommendation I, level of evidence C)

Bivalirudin (with use of GP IIb/IIIa blocker restricted to bailout) is recommended over unfractionated heparin and a GP IIb/IIIa blocker. (Class of recommendation I, level of evidence B) (Stone et al., 2008)

Enoxaparin (with or without routine GP IIb/IIIa blocker) may be preferred over unfractionated heparin. (Class of recommendation IIb, level of evidence B) (Montalescot et al., 2011)

Unfractionated heparin with or without routine GP IIb/IIIa blocker must be used in patients not receiving bivalirudin or enoxaparin. (Class of

recommendation I, level of evidence C) (Van de Werf et al., 2008)

Fondaparinux is not recommended for primary PCI. (Class of recommendation III, level of evidence B) (Yusuf et al., 2006)

The use of fibrinolysis before planned primary PCI is not recommended. (Class of recommendation III, level of evidence A) (Ellis et al., 2008; Assessment of the Safety and Efficacy of a New Treatment Strategy with Percutaneous Coronary Intervention [ASSENT-4 PCI] Investigators, 2006)

Fibrinolytic Therapy

Fibrinolytic therapy is recommended within 12 h of symptom onset in patients without contraindications if primary PCI cannot be performed by an experienced team within 120 min of FMC. (Class of recommendation I, level of evidence A) (Van de Werf et al., 2008; Pinto et al., 2006)

In patients presenting early (<2 h after symptom onset) with a large infarct and low bleeding risk, fibrinolysis should be considered if time from FMC to balloon inflation is >90 min. (Class of recommendation IIa, level of evidence B) (Steg et al., 2003; Pinto et al., 2006; Bonnefoy et al., 2002)

If possible, fibrinolysis should start in the prehospital setting. (Class of recommendation IIa, level of evidence A) (Morrison et al., 2000; Bonnefoy et al., 2002; Bjorklund et al., 2006)

A fibrin-specific agent (tenecteplase, alteplase, reteplase) is recommended (over non-fibrin specific agents). (Class of recommendation I, level of evidence B) (Assessment of the Safety and Efficacy of a New Thrombolytic [ASSENT-2] et al., 1999; "An international randomized trial," 1993).

Oral or i.v. aspirin must be administered. (Class of recommendation I, level of evidence B) ("Randomised trial," 1988)

Clopidogrel is indicated in addition to aspirin. (Class of recommendation I, level of evidence A) (Chen et al., "Addition of clopidogrel," 2005; Sabatine et al., 2005)

<u>Antithrombin Co-therapy with Fibrinolysis</u>

Anticoagulation is recommended in STEMI patients treated with lytics until revascularization (if performed) or for the duration of hospital stay up to 8 days. The anticoagulant can be (Class of recommendation I, level of evidence A) (Yusuf et al., 2006; "An international randomized trial," 1993; Assessment of the Safety and Efficacy of a New Thrombolytic Regimen [ASSENT]-3 Investigators, 2001; Wallentin et al., 2003; Giraldez et al., 2007; White et al., 2007; Ross et al., 2001; Antman et al., 2002; Peters et al., 2008):

- Enoxaparin i.v. followed by subcutaneous (s.c.) (using the regimen described below) (preferred over unfractionated heparin [UFH]) (Class of recommendation I, level of evidence A) (Assessment of the Safety and Efficacy of a New Thrombolytic Regimen [ASSENT]-3 Investigators, 2001; Wallentin et al., 2003; Giraldez et al., 2007; White et al., 2007; Ross et al., 2001; Antman et al., 2002)
- UFH given as a weight-adjusted i.v. bolus and infusion (Class of recommendation I, level of evidence C) ("An international randomized trial," 1993)

In patients treated with streptokinase, fondaparinux i.v. bolus followed by s.c. dose 24 h later. (Class of recommendation IIa, level of evidence B) (Yusuf et al., 2006; Peters et al., 2008)

<u>Transfer to a PCI-capable Centre Following Fibrinolysis</u>

Is indicated in all patients after fibrinolysis. (Class of recommendation I, level of evidence A) (Gershlick et al., 2005; Ellis et al., 1994; Hochman et al., 2001; Cantor et al., 2009; Di Mario et al., 2008; Bohmer et al., 2010; Fernandez-Aviles et al., 2004)

<u>Interventions Following Fibrinolysis</u>

Rescue PCI is indicated immediately when fibrinolysis has failed (<50% ST-segment resolution at 60 min). (Class of recommendation I, level of evidence A) (Gershlick et al., 2005; Ellis et al., 1994)

Emergency PCI is indicated in the case of recurrent ischaemia or evidence of reocclusion after initial successful fibrinolysis. (Class of recommendation I, level of evidence B) (Gershlick et al., 2005)

Emergency angiography with a view to revascularization is indicated in heart failure/shock patients. (Class of recommendation I, level of evidence A) (Hochman et al., 2001)

Angiography with a view to revascularization (of the infarct-related artery) is indicated after successful fibrinolysis. (Class of recommendation I,

level of evidence A) (Cantor et al., 2009; Di Mario et al., 2008; Bohmer et al., 2010; Fernandez-Aviles et al., 2004)

Optimal timing of angiography for stable patients after successful lysis: 3–24 h. (Class of recommendation IIa, level of evidence A) (Borgia et al., 2010).

Special Subsets

Both genders must be managed in a similar fashion. (Class of recommendation I, level of evidence C)

A high index of suspicion for myocardial infarction must be maintained in women, diabetics, and elderly patients with atypical symptoms. (Class of recommendation I, level of evidence B) (Brieger et al., 2009)

Special attention must be given to proper dosing of antithrombotics in elderly and renal failure patients. (Class of recommendation I, level of evidence B) (Alexander et al., 2005)

Management of Hyperglycaemia in ST-segment Elevation Myocardial Infarction

Measurement of glycaemia is indicated at initial evaluation in all patients, and should be repeated in patients with known diabetes or hyperglycaemia. (Class of recommendation I, level of evidence C)

Plans for optimal outpatient glucose control and secondary prevention must be determined in patients with diabetes before discharge. (Class of recommendation I, level of evidence C)

The goals of glucose control in the acute phase should be to maintain glucose concentrations ≤11.0 mmol/L (200 mg/dL) while avoiding fall of glycaemia <5 mmol/L (<90 mg/dL). In some patients, this may require a dose-adjusted insulin infusion with monitoring of glucose, as long as hypoglycaemia is avoided. (Class of recommendation IIa, level of evidence B) (De Caterina et al., 2010; NICE-SUGAR Study Investigators et al., 2009; Kosiborod & McGuire, 2010)

A measurement of fasting glucose and haemoglobin A1c (HbA1c) and, in some cases, a post-discharge oral glucose tolerance test should be considered in patients with hyperglycaemia but without a history of diabetes. (Class of recommendation IIa, level of evidence B) (Bartnik et al., 2004)

Routine glucose-insulin-potassium infusion is not indicated. (Class of recommendation III, level of evidence A) (Yusuf et al., 2006; Diaz et al., 2007)

Management during Hospitalization and at Discharge

Coronary Care Unit Logistics and Monitoring

Logistical Issues for Hospital Stay

All hospitals participating in the care of STEMI patients should have a coronary care unit equipped to provide all aspects of care for STEMI patients, including treatment of ischaemia, severe heart failure, arrhythmias and common comorbidities. (Class of recommendation I, level of evidence C)

Length of Stay in the Coronary Care Unit

Patients undergoing uncomplicated successful reperfusion therapy should be kept in the coronary care unit for a minimum of 24 h, after which they may be moved to a step-down monitored bed for another 24–48 h. (Class of recommendation I, level of evidence C)

Transfer Back to a Referring Non-PCI Hospital

Early transfer (same day) may be considered in selected, low-risk patients after successful primary PCI without observed arrhythmia. (Class of recommendation IIb, level of evidence C)

Hospital Discharge

Early discharge (after approximately 72 h) is reasonable in selected low-risk patients, if early rehabilitation and adequate follow-up are arranged. (Class of recommendation IIb, level of evidence B) (Grines et al., 1998; Newby et al., 2003; Kotowycz et al., 2010)

Risk Assessment and Imaging

Summary of Indications for Imaging and Stress Testing

<u>At Presentation</u>

In the acute phase, when diagnosis is uncertain, emergency echocardiography may be useful. However, if inconclusive or unavailable and persistent doubt, emergency angiography should be considered. (Class of recommendation I, level of evidence C)

<u>After the Acute Phase</u>

All patients should have an echocardiogram for assessment of infarct size and resting left ventricular (LV) function. (Class of recommendation I, level of evidence B) (Allman et al., 2002; St John Sutton et al., 1994)

If echocardiography is not feasible, magnetic resonance imaging (MRI) may be used as an alternative. (Class of recommendation IIb, level of evidence C)

<u>Before or after Discharge</u>

For patients with multivessel disease, or in whom revascularization of other vessels is considered, stress testing or imaging (e.g., using stress myocardial perfusion scintigraphy, stress echocardiography, positron emission tomography or MRI) for ischaemia and viability is indicated. (Class of recommendation I, level of evidence A) (Task Force on Myocardial Revascularization of the European Society of Cardiology [ESC] et al., 2010; Allman et al., 2002; Beanlands et al., 2007)

Computed tomography angiography has no role in the routine management of STEMI patients. (Class of recommendation III, level of evidence C)

Long-term Therapies for ST-segment Elevation Myocardial Infarction

Routine Therapies in the Acute, Subacute and Long-term Phase of ST-segment Elevation Myocardial Infarction

Active smokers with STEMI must receive counselling and be referred to a smoking cessation programme. (Class of recommendation I, level of evidence B) (Thomson & Rigotti, 2003)

Each hospital participating in the care of STEMI patients must have a smoking cessation protocol. (Class of recommendation I, level of evidence C)

Exercise-based rehabilitation is recommended. (Class of recommendation I, level of evidence B) (Lawler, Filion, & Eisenberg, 2011; Heran et al., 2011)

Antiplatelet therapy with low dose aspirin (75–100 mg) is indicated indefinitely after STEMI. (Class of recommendation I, level of evidence A) (Antithrombotic Trialists' [ATT] Collaboration et al., 2009)

In patients who are intolerant to aspirin, clopidogrel is indicated as an alternative to aspirin. (Class of recommendation I, level of evidence B) (CAPRIE Steering Committee, 1996)

DAPT with a combination of aspirin and prasugrel or aspirin and ticagrelor is recommended (over aspirin and clopidogrel) in patients treated with PCI. (Class of recommendation I, level of evidence A) (Wiviott et al., 2007; Wallentin et al., 2009)

DAPT with aspirin and an oral adenosine diphosphate (ADP) receptor antagonist must be continued for up to 12 months after STEMI, with a strict minimum of: (Class of recommendation I, level of evidence C)

- 1 month for patients receiving BMS (Class of recommendation I, level of evidence C)
- 6 months for patients receiving DES (Class of recommendation IIb, level of evidence B)

(Gwon et al., 2012; Park et al., 2010; Valgimigli et al., "Randomized comparison," 2010; Steinhubl et al., 2002)

In patients with left ventricular thrombus, anticoagulation should be instituted for a minimum of 3 months. (Class of recommendation IIa, level of evidence B) (Reeder et al., 1981; Keeley & Hillis, 1996; Turpie et al., 1989)

In patients with a clear indication for oral anticoagulation (e.g., atrial fibrillation with CHA_2DS_2-VASc* Score ≥ 2 or mechanical valve prosthesis), oral anticoagulation must be implemented in addition to antiplatelet therapy. (Class of recommendation I, level of evidence C)

*Cardiac failure, Hypertension, Age ≥ 75 (Doubled), Diabetes, Stroke (Doubled) – VAScular disease, Age 65–74 and Sex category (Female)

If patients require triple antithrombotic therapy, combining DAPT and oral anticoagulation (OAC), e.g., because of stent placement and an obligatory indication for OAC, the duration of dual antiplatelet therapy should be minimized to reduce bleeding risk. (Class of recommendation I,

level of evidence C)

In selected patients who receive aspirin and clopidogrel, low-dose rivaroxaban (2.5 mg twice daily) may be considered if the patient is at low bleeding risk. (Class of recommendation IIb, level of evidence B) (Mega et al., 2012)

DAPT should be used up to 1 year in patients with STEMI who did not receive a stent. (Class of recommendation IIa, level of evidence C)

Gastric protection with a proton pump inhibitor should be considered for the duration of DAPT therapy in patients at high risk of bleeding. (Class of recommendation IIa, level of evidence C) (Abraham et al., 2010)

Oral treatment with beta-blockers should be considered during hospital stay and continued thereafter in all STEMI patients without contraindications. (Class of recommendation IIa, level of evidence B) (Van de Werf et al., 2008; Chen et al., "Early intravenous," 2005)

Oral treatment with beta-blockers is indicated in patients with heart failure or LV dysfunction. (Class of recommendation I, level of evidence A) (Dickstein et al., 2008; Dargie, 2001; Packer et al., 2001; "The Cardiac Insufficiency Bisoprolol Study II [CIBIS-II]," 1999; Poole-Wilson et al., 2003)

Intravenous beta-blockers must be avoided in patients with hypotension or heart failure. (Class of recommendation III, level of evidence B) (Chen et al., "Early intravenous," 2005)

Intravenous beta-blockers should be considered at the time of presentation in patients without contraindications, with high blood pressure, tachycardia and no signs of heart failure. (Class of recommendation IIa, level of evidence B) (Chen et al., "Early intravenous," 2005)

A fasting lipid profile must be obtained in all STEMI patients, as soon as possible after presentation. (Class of recommendation I, level of evidence C)

It is recommended to initiate or continue high dose statins early after admission in all STEMI patients without contraindication or history of intolerance, regardless of initial cholesterol values. (Class of recommendation I, level of evidence A) (Baigent et al., 2005)

Reassessment of low-density lipoprotein (LDL)-cholesterol should be considered after 4–6 weeks to ensure that a target value of ≤1.8 mmol/L (70 mg/dL) has been reached. (Class of recommendation IIa, level of evidence C) (European Association for Cardiovascular Prevention & Rehabilitation et al., 2011)

Verapamil may be considered for secondary prevention in patients with absolute contraindications to beta-blockers and no heart failure. (Class of recommendation IIb, level of evidence B) ("Secondary prevention with verapamil," 1990)

Angiotensin-converting enzyme (ACE) inhibitors are indicated starting within the first 24 h of STEMI in patients with evidence of heart failure, LV systolic dysfunction, diabetes or an anterior infarct. (Class of recommendation I, level of evidence A) ("ISIS-4: a randomised factorial trial," 1995)

An angiotensin receptor blocker (ARB), preferably valsartan, is an alternative to ACE inhibitors in patients with heart failure or LV systolic dysfunction, particularly those who are intolerant to ACE inhibitors. (Class of recommendation I, level of evidence B) (Dickstein, Kjekshus & OPTIMALL Steering Committee of the OPTIMAAL Study Group, 2002; Pfeffer et al., 2003)

ACE inhibitors should be considered in all patients in the absence of contraindications. (Class of recommendation IIa, level of evidence A) (Fox, 2003; Yusuf et al., 2000)

Aldosterone antagonists, e.g., eplerenone, are indicated in patients with an ejection fraction ≤40% and heart failure or diabetes, provided no renal failure or hyperkalaemia. (Class of recommendation I, level of evidence B) (Pitt et al., 2003)

Complications following ST-segment Elevation Myocardial Infarction

Haemodynamic Disturbances

Treatment of Heart Failure and Left Ventricular Dysfunction

Treatment of Mild Heart Failure (Killip Class II)

Oxygen is indicated to maintain a saturation >95%. (Class of recommendation I, level of evidence C)

Loop diuretics, e.g., furosemide: 20–40 mg i.v., are recommended and should be repeated at 1–4 h intervals if necessary. (Class of recommendation I, level of evidence C)

Intravenous nitrates or sodium nitroprusside should be considered in patients with elevated systolic blood pressure. (Class of recommendation IIa, level of evidence C)

An ACE inhibitor is indicated in all patients with signs or symptoms of heart failure and/or evidence of LV dysfunction in the absence of hypotension, hypovolaemia, or renal failure. (Class of recommendation I, level of evidence A) (McAlister et al., 2004; "Effect of ramipril," 1993; Pfeffer et al., 1992; Kober et al., 1995)

An ARB (valsartan) is an alternative to ACE inhibitors particularly if ACE inhibitors are not tolerated. (Class of recommendation I, level of evidence B) (Pfeffer et al., 2003)

An aldosterone antagonist (eplerenone) is recommended in all patients with signs or symptoms of heart failure and/or evidence of LV dysfunction provided no renal failure or hyperkalaemia. (Class of recommendation I, level of evidence B) (Pitt et al., 2003)

Hydralazine and isosorbide dinitrate should be considered if the patient is intolerant to both ACE inhibitors and ARBs. (Class of recommendation IIa, level of evidence C) (Taylor et al., 2004)

Treatment of Moderate Heart Failure (Killip Class III)

Oxygen is indicated. (Class of recommendation I, level of evidence C)

Ventilatory support should be instituted according to blood gasses. (Class of recommendation I, level of evidence C)

Loop diuretics, e.g., furosemide: 20–40 mg i.v., are recommended and should be repeated at 1–4 h intervals if necessary. (Class of recommendation I, level of evidence C)

Morphine is recommended. Respiration should be monitored. Nausea is common and an antiemetic may be required. Frequent low-dose therapy is advisable. (Class of recommendation I, level of evidence C)

Nitrates are recommended if there is no hypotension. (Class of recommendation I, level of evidence C)

Inotropic agents:

- Dopamine (Class of recommendation IIa, level of evidence C)
- Dobutamine (inotropic) (Class of recommendation IIa, level of evidence C)
- Levosimendan (inotropic/vasodilator) (Class of recommendation IIb, level of evidence C)

An aldosterone antagonist such as spironolactone or eplerenone must be used if left ventricular ejection fraction (LVEF) ≤40%. (Class of recommendation I, level of evidence B) (Pitt et al., 2003; Pitt et al., 1999)

Ultrafiltration should be considered. (Class of recommendation IIa, level of evidence B) (Costanzo et al., 2007)

Early revascularization must be considered if the patient has not been previously revascularized. (Class of recommendation I, level of evidence C)

Treatment of Cardiogenic Shock (Killip Class IV)

Oxygen/mechanical respiratory support is indicated according to blood gasses. (Class of recommendation I, level of evidence C)

Urgent echocardiography/Doppler must be performed to detect mechanical complications, assess systolic function and loading conditions. (Class of recommendation I, level of evidence C)

High-risk patients must be transferred early to tertiary centres. (Class of recommendation I, level of evidence C)

Emergency revascularization with either PCI or coronary artery bypass graft (CABG) in suitable patients must be considered. (Class of recommendation I, level of evidence B) (Hochman et al., 1999)

Fibrinolysis should be considered if revascularization is unavailable. (Class of recommendation IIa, level of evidence C)

Intra-aortic balloon pumping may be considered. (Class of recommendation IIb, level of evidence B) (Van de Werf et al., 2008; Sjauw et al., 2009; Bahekar et al., 2012)

LV assist devices may be considered for circulatory support in patients in refractory shock. (Class of recommendation IIb, level of evidence C)

Haemodynamic assessment with balloon floating catheter may be considered. (Class of recommendation IIb, level of evidence B) (Shah et al.,

2005)

Inotropic/vasopressor agents should be considered:

- Dopamine (Class of recommendation IIa, level of evidence C)
- Dobutamine (Class of recommendation IIa, level of evidence C)
- Norepinephrine (preferred over dopamine when blood pressure is low) (Class of recommendation IIb, level of evidence B) (De Backer et al., 2010; Levy et al., 2011)

Management of Atrial Fibrillation

Rhythm control should be considered in patients with atrial fibrillation secondary to a trigger or substrate that has been corrected (e.g., ischaemia). (Class of recommendation IIa, level of evidence C)

Acute Rate Control of Atrial Fibrillation

Intravenous beta-blockers or non-dihydropyridine calcium channel blockers (CCBs, e.g., diltiazem, verapamil) are indicated if there are no clinical signs of acute heart failure. (Class of recommendation I, level of evidence A) (Segal et al., 2000). (Note: Calcium antagonists should be used cautiously or avoided in patients with heart failure because of their negative inotropic effects.)

Amiodarone or i.v. digitalis is indicated in case of rapid ventricular response in the presence of concomitant acute heart failure or hypotension. (Class of recommendation I, level of evidence B) (Hou et al., 1995)

Cardioversion

Immediate electrical cardioversion is indicated when adequate rate control cannot be achieved promptly with pharmacological agents in patients with atrial fibrillation and on-going ischaemia, severe haemodynamic compromise or heart failure. (Class of recommendation I, level of evidence C)

Intravenous amiodarone is indicated for conversion to sinus rhythm in stable patients with recent onset atrial fibrillation and structural heart disease. (Class of recommendation I, level of evidence A) (European Heart Rhythm Association et al., 2010)

Digoxin (level of evidence A), verapamil, sotalol, metoprolol (level of evidence B) and other beta-blocking agents (level of evidence C) are ineffective in converting recent onset atrial fibrillation to sinus rhythm and should not be used for rhythm control (although beta-blockers or digoxin may be used for rate control). (Class of recommendation III, level of evidence A, B, C) (European Heart Rhythm Association et al., 2010)

Management of Ventricular Arrhythmias and Conduction Disturbances in the Acute Phase

Direct current cardioversion is indicated for sustained ventricular tachycardia (VT) and ventricular fibrillation (VF). (Class of recommendation I, level of evidence C)

Sustained monomorphic VT that is recurrent or refractory to direct current cardioversion:

- Should be considered to be treated with i.v. amiodarone.* (Class of recommendation IIa, level of evidence C)
- May be treated with i.v. lidocaine or sotalol** (Class of recommendation IIb, level of evidence C)

Transvenous catheter pace termination should be considered if VT is refractory to cardioversion or frequently recurrent despite antiarrhythmic medication. (Class of recommendation IIa, level of evidence C)

Repetitive symptomatic salvoes of non-sustained monomorphic VT should be considered for either conservative management (watchful waiting) or treated with i.v. beta-blocker,** or sotalol,** or amiodarone.* (Class of recommendation IIa, level of evidence C)

Polymorphic VT:

- Must be treated by i.v. beta-blocker** (Class of recommendation I, level of evidence B) (Piccini et al., 2008; Huikuri et al., 1989)
- Or i.v. amiodarone* (Class of recommendation I, level of evidence C)
- Urgent angiography must be performed when myocardial ischaemia cannot be excluded (Class of recommendation I, level of evidence C)
- May be treated with i.v. lidocaine (Class of recommendation IIb, level of evidence C) (Piccini et al., 2011)
- Must prompt assessment and correction of electrolyte disturbances, consider magnesium (Class of recommendation I, level of evidence C)
- Should be treated with overdrive pacing using a temporary transvenous right ventricular lead or isoproterenol infusion (Class of recommendation IIa, level of evidence C)

In cases of sinus bradycardia associated with hypotension, atrioventricular (AV) block II (Mobitz 2) or AV block III with bradycardia that causes hypotension or heart failure:

- Intravenous atropine is indicated (Class of recommendation I, level of evidence C)
- Temporary pacing is indicated in cases of failure to respond to atropine (Class of recommendation I, level of evidence C)
- Urgent angiography with a view to revascularization is indicated if the patient has not received prior reperfusion therapy (Class of recommendation I, level of evidence C)

*QT-prolonging agents should not be used if baseline QT is prolonged.

**Intravenous sotalol or other beta-blockers should not be given if ejection fraction is low.

Management of Ventricular Arrhythmias and Risk Evaluation for Sudden Death on Long Term

Specialized electrophysiological evaluation of implantable cardioverter defibrillator (ICD) implantation for secondary prevention of sudden cardiac death is indicated in patients with significant LV dysfunction, who suffer from haemodynamically unstable sustained VT or who are resuscitated from VF occurring beyond the initial acute phase. (Class of recommendation I, level of evidence A) (Lee et al., 2003)

Secondary preventive ICD therapy is indicated to reduce mortality in patients with significant LV dysfunction, and haemodynamically unstable sustained VT or survived VF, not occurring within the initial acute phase. (Class of recommendation I, level of evidence A) (Lee et al., 2003)

Risk evaluation for sudden cardiac death should be performed to assess indication for primary preventive ICD therapy by assessing LVEF (from echocardiography) at least 40 days after the acute event in patients with LVEF ≤40%. (Class of recommendation I, level of evidence A) (Lee et al., 2003)

Definitions:

Levels of Evidence

Level of Evidence A	Data derived from multiple randomized clinical trials or meta-analyses.
Level of Evidence B	Data derived from a single randomized clinical trial or large non-randomized studies.
Level of Evidence C	Consensus of opinion of the experts and/or small studies, retrospective studies, registries.

Classes of Recommendations

Classes of Recommendations	Definition	Suggested Wording to Use
Class I	Evidence and/or general agreement that a given treatment or procedure is beneficial, useful, effective.	Is recommended/is indicated
Class II	Conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of the given treatment or procedure.	
Class IIa	Weight of evidence/opinion is in favour of usefulness/efficacy.	Should be considered
Class IIb	Usefulness/efficacy is less well established by evidence/opinion.	May be considered
Class III	Evidence or general agreement that the given treatment or procedure is not useful/effective, and in some cases may be harmful.	Is not recommended

Clinical Algorithm(s)

The following algorithms are provided in the original guideline document:

- Prehospital and in-hospital management, and reperfusion strategies within 24 h of first medical contact (FMC)

- Components of delay in ST-segment elevation myocardial infarction (STEMI) and ideal time intervals for intervention

Scope

Disease/Condition(s)

- Acute myocardial infarction with ST-segment elevation (STEMI)
- Complications following STEMI (haemodynamic disturbances, cardiac complications)

Guideline Category

Diagnosis

Management

Risk Assessment

Treatment

Clinical Specialty

Cardiology

Critical Care

Emergency Medicine

Family Practice

Geriatrics

Internal Medicine

Intended Users

Advanced Practice Nurses

Allied Health Personnel

Emergency Medical Technicians/Paramedics

Nurses

Physician Assistants

Physicians

Guideline Objective(s)

- To present updated recommendations on the management of acute myocardial infarction in patients presenting with ST-segment elevation
- To assist physicians in selecting the best management strategies for a typical patient, suffering from a given condition, taking into account the impact on outcome, as well as the risk/benefit ratio of particular diagnostic or therapeutic means

Target Population

Patients presenting with ischaemic symptoms and persistent ST-segment elevation on the electrocardiogram (ST-segment elevation myocardial infarction [STEMI])

Interventions and Practices Considered

Diagnosis

1. Initial diagnosis of ST-segment elevation myocardial infarction (STEMI)
   - Patient history (history of chest pain/discomfort)
   - 12-lead electrocardiogram (ECG) monitoring
   - Use of additional posterior chest wall leads (V7–V9 ≥0.05 mV)
   - Blood sampling for serum markers
   - Echocardiography

Management/Treatment

1. Management during emergency care
   - Relief of pain, breathlessness, and anxiety (intravenous opioids, oxygen, tranquilize)
   - Management of cardiac arrest
     - Medical/paramedical personnel access to defibrillation equipment and training in cardiac life support
     - ECG monitoring at the point of first-medical-contact
     - Use of therapeutic hypothermia
     - Immediate angiography
   - Pre-hospital logistics of care
     - Initial therapy, including thrombolysis, delivered by ambulance teams
     - Regional networks designed to deliver reperfusion therapy
     - Primary percutaneous coronary intervention (PCI)-capable centres for expeditious 24/7 service
     - Quality targets and written management protocols
   - Reperfusion therapy/procedural aspects of primary PCI
     - Timing and access points
     - Stenting versus balloon angioplasty alone
     - Drug-eluting versus bare-metal stents
   - Periprocedural antithrombotic medication in primary PCI
     - Antiplatelet therapy (aspirin, prasugrel, ticagrelor, clopidogrel, glycoprotein [GP] IIb/IIIa inhibitors)
     - Anticoagulants (bivalirudin, enoxaparin, unfractionated heparin, GP IIb/IIa inhibitor) (fondaparinux not recommended)
   - Fibrinolytic therapy
     - Timing of fibrinolytic therapy
     - Use of fibrin-specific agent (tenecteplase, alteplase, reteplase)
     - Aspirin and clopidogrel
     - Anti-thrombin co-therapy with fibrinolysis
     - Transfer to a PCI-capable centre following fibrinolysis
     - Rescue or emergency PCI
     - Emergency angiography
     - Special considerations in women, diabetics, the elderly, and in renal failure
   - Management of hyperglycaemia
2. Management during hospitalization and at discharge
   - Logistical issues for hospital stay (length of stay, transfer back to non-PCI hospital, discharge)
   - Imaging and stress testing (echocardiography, emergency angiography, magnetic resonance imaging [MRI])
   - Routine therapies in the acute, subacute and long-term phase of STEMI
     - Smoking cession programme
     - Exercise-based rehabilitation
     - Dual antiplatelet therapy (DAPT)
     - Anticoagulation
     - Gastric protection with a proton pump inhibitor
     - Beta-blockers (oral or intravenous)

- Fasting lipid profile
  - Statin therapy
  - Verapamil
  - Angiotensin-converting enzyme inhibitors or angiotensin receptor blockers
  - Aldosterone antagonists
3. Management of complications following STEMI
  - Management of heart failure and left ventricular dysfunction
  - Management of atrial fibrillation
  - Management of ventricular arrhythmias and conduction disturbances in the acute phase

Major Outcomes Considered

- Time since onset of symptoms
- Complications of myocardial infarction
- Mortality (all-cause and cardiovascular)
- Risk of stroke
- Risk of re-infarction or re-occlusion
- Major bleeding rates

Methodology

Methods Used to Collect/Select the Evidence

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

The PubMed, Medline, Scopus, EMBASE, and Cochrane databases were searched over the 10 previous years for the following terms: guidelines, acute myocardial infarction, ST-segment elevation, acute coronary syndromes, ischaemic heart disease, reperfusion therapy, primary percutaneous coronary intervention, antithrombotic therapy, secondary prevention.

Number of Source Documents

Not stated

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Levels of Evidence

Level of Evidence A	Data derived from multiple randomized clinical trials or meta-analyses.
Level of Evidence B	Data derived from a single randomized clinical trial or large non-randomized studies.
Level of Evidence C	Consensus of opinion of the experts and/or small studies, retrospective studies, registries.

Methods Used to Analyze the Evidence

Review of Published Meta-Analyses

Systematic Review

Description of the Methods Used to Analyze the Evidence

A critical evaluation of diagnostic and therapeutic procedures was performed, including assessment of the risk–benefit ratio. Estimates of expected health outcomes for larger populations were included, where data exist. The levels of evidence and the strengths of recommendation of particular treatment options were weighed and graded according to predefined scales (see the "Rating Scheme for the Strength of the Evidence" and the "Rating Scheme for the Strength of the Recommendations" fields).

Methods Used to Formulate the Recommendations

Expert Consensus

Description of Methods Used to Formulate the Recommendations

Members of this Task Force were selected by the European Society of Cardiology (ESC) to represent professionals involved with the medical care of patients with this pathology. Selected experts in the field undertook a comprehensive review of the published evidence for diagnosis, management, and/or prevention of a given condition according to ESC Committee for Practice Guidelines (CPG) policy.

Rating Scheme for the Strength of the Recommendations

Classes of Recommendations

Classes of Recommendations	Definition	Suggested Wording to Use
Class I	Evidence and/or general agreement that a given treatment or procedure is beneficial, useful, effective.	Is recommended/is indicated
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Class IIb	*Usefulness/efficacy is less well established by evidence/opinion.*	May be considered
Class III	Evidence or general agreement that the given treatment or procedure is not useful/effective, and in some cases may be harmful.	Is not recommended

Cost Analysis

The guideline developers reviewed published cost analyses.

Method of Guideline Validation

External Peer Review

Internal Peer Review

Description of Method of Guideline Validation

The European Society of Cardiology (ESC) Guidelines undergo extensive review by the Committee for Practice Guidelines (CPG) and external experts. After appropriate revisions, it is approved by all the experts involved in the Task Force. The finalized document is approved by the CPG for publication in the *European Heart Journal*.

Evidence Supporting the Recommendations

References Supporting the Recommendations

Abraham NS, Hlatky MA, Antman EM, Bhatt DL, Bjorkman DJ, Clark CB, Furberg CD, Johnson DA, Kahi CJ, Laine L, Mahaffey KW, Quigley EM, Scheiman J, Sperling LS, Tomaselli GF, ACCF/ACG/AHA. ACCF/ACG/AHA 2010 expert consensus document on the concomitant use of proton pump inhibitors and thienopyridines: a focused update of the ACCF/ACG/AHA 2008 expert consensus document on reducing the gastrointestinal risks of antiplatelet therapy [trunc]. J Am Coll Cardiol. 2010 Dec 7;56(24):2051-66. PubMed

Akerblom A, James SK, Koutouzis M, Lagerqvist B, Stenestrand U, Svennblad B, Oldgren J. Eptifibatide is noninferior to abciximab in primary percutaneous coronary intervention: results from the SCAAR (Swedish Coronary Angiography and Angioplasty Registry). J Am Coll Cardiol. 2010 Aug 3;56(6):470-5. PubMed

Alexander KP, Chen AY, Roe MT, Newby LK, Gibson CM, Allen-LaPointe NM, Pollack C, Gibler WB, Ohman EM, Peterson ED, CRUSADE Investigators. Excess dosing of antiplatelet and antithrombin agents in the treatment of non-ST-segment elevation acute coronary syndromes. JAMA. 2005 Dec 28;294(24):3108-16. PubMed

Allman KC, Shaw LJ, Hachamovitch R, Udelson JE. Myocardial viability testing and impact of revascularization on prognosis in patients with coronary artery disease and left ventricular dysfunction: a meta-analysis. J Am Coll Cardiol. 2002 Apr 3;39(7):1151-8. PubMed

An international randomized trial comparing four thrombolytic strategies for acute myocardial infarction. The GUSTO investigators. N Engl J Med. 1993 Sep 2;329(10):673-82. PubMed

Antithrombotic Trialists' (ATT) Collaboration, Baigent C, Blackwell L, Collins R, Emberson J, Godwin J, Peto R, Buring J, Hennekens C, Kearney P, Meade T, Patrono C, Roncaglioni MC, Zanchetti A. Aspirin in the primary and secondary prevention of vascular disease: collaborative meta-analysis of individual participant data from randomised trials. Lancet. 2009 May 30;373(9678):1849-60. PubMed

Antman EM, Louwerenburg HW, Baars HF, Wesdorp JC, Hamer B, Bassand JP, Bigonzi F, Pisapia G, Gibson CM, Heidbuchel H, Braunwald E, Van de Werf F. Enoxaparin as adjunctive antithrombin therapy for ST-elevation myocardial infarction [trunc] [Erratum in Circulation 2002 Jun 11;105(23):2799]. Circulation. 2002 Apr 9;105(14):1642-9. PubMed

Assessment of the Safety and Efficacy of a New Thrombolytic (ASSENT-2), Van De Werf F, Adgey J, Ardissino D, Armstrong PW, Aylward P, Barbash G, Betriu A, Binbrek AS, Califf R, Diaz R, Fanebust R, Fox K, Granger C, Heikkila J, Husted S, Jansky P, Langer A, Lupi E, Maseri A, Meyer J, Mlczoch J, Mocceti D, Myburgh D, Oto A, Paolasso E, Pehrsson K, Seabra-Gomes R, Soares-Piegas L, Sugrue D, Tendera M, Topol E, Toutouzas P, Vahanian A, Verheugt F, Wallentin L, White H. Single-bolus tenecteplase compared with front-loaded alteplase in acute myocardial infarction: the ASSENT-2 double-blind randomised trial. Lancet. 1999 Aug 28;354(9180):716-22. PubMed

Assessment of the Safety and Efficacy of a New Thrombolytic Regimen (ASSENT)-3 Investigators. Efficacy and safety of tenecteplase in combination with enoxaparin, abciximab, or unfractionated heparin: the ASSENT-3 randomised trial in acute myocardial infarction. Lancet. 2001 Aug 25;358(9282):605-13. PubMed

Assessment of the Safety and Efficacy of a New Treatment Strategy [trunc]. Primary versus tenecteplase-facilitated percutaneous coronary intervention in patients with ST-segment elevation acute myocardial infarction (ASSENT-4 PCI): randomised trial. Lancet. 2006 Feb 18;367(9510):569-78. PubMed

Bahekar A, Singh M, Singh S, Bhuriya R, Ahmad K, Khosla S, Arora R. Cardiovascular outcomes using intra-aortic balloon pump in high-risk acute myocardial infarction with or without cardiogenic shock: a meta-analysis. J Cardiovasc Pharmacol Ther. 2012 Mar;17(1):44-56. PubMed

Baigent C, Keech A, Kearney PM, Blackwell L, Buck G, Pollicino C, Kirby A, Sourjina T, Peto R, Collins R, Simes R. Efficacy and safety of cholesterol-lowering treatment: prospective meta-analysis of data from 90,056 participants in 14 randomised trials of statins. Lancet. 2005 Oct 8;366(9493):1267-78. PubMed

Bartnik M, Malmberg K, Norhammar A, Tenerz A, Ohrvik J, Ryden L. Newly detected abnormal glucose tolerance: an important predictor of long-term outcome after myocardial infarction. Eur Heart J. 2004 Nov;25(22):1990-7. PubMed

Bavry AA, Kumbhani DJ, Bhatt DL. Role of adjunctive thrombectomy and embolic protection devices in acute myocardial infarction: a comprehensive meta-analysis of randomized trials. Eur Heart J. 2008 Dec;29(24):2989-3001. [50 references] PubMed

Beanlands RS, Nichol G, Huszti E, Humen D, Racine N, Freeman M, Gulenchyn KY, Garrard L, deKemp R, Guo A, Ruddy TD, Benard F, Lamy A, Iwanochko RM, PARR-2 Investigators. F-18-fluorodeoxyglucose positron emission tomography imaging-assisted management of patients with severe left ventricular dysfunction and suspected coronary disease: a randomized, controlled trial (PARR-2). J Am Coll Cardiol. 2007 Nov 13;50(20):2002-12. PubMed

Belliard G, Catez E, Charron C, Caille V, Aegerter P, Dubourg O, Jardin F, Vieillard-Baron A. Efficacy of therapeutic hypothermia after out-of-hospital cardiac arrest due to ventricular fibrillation. Resuscitation. 2007 Nov;75(2):252-9. PubMed

Bernard SA, Gray TW, Buist MD, Jones BM, Silvester W, Gutteridge G, Smith K. Treatment of comatose survivors of out-of-hospital cardiac arrest with induced hypothermia. N Engl J Med. 2002 Feb 21;346(8):557-63. PubMed

Bjorklund E, Stenestrand U, Lindback J, Svensson L, Wallentin L, Lindahl B. Pre-hospital thrombolysis delivered by paramedics is associated with reduced time delay and mortality in ambulance-transported real-life patients with ST-elevation myocardial infarction. Eur Heart J. 2006 May;27(10):1146-52. PubMed

Boersma E, Maas AC, Deckers JW, Simoons ML. Early thrombolytic treatment in acute myocardial infarction: reappraisal of the golden hour. Lancet. 1996 Sep 21;348(9030):771-5. PubMed

Boersma E, Primary Coronary Angioplasty vs. Thrombolysis Group. Does time matter? A pooled analysis of randomized clinical trials comparing primary percutaneous coronary intervention and in-hospital fibrinolysis in acute myocardial infarction patients. Eur Heart J. 2006 Apr;27(7):779-88. PubMed

Bohmer E, Hoffmann P, Abdelnoor M, Arnesen H, Halvorsen S. Efficacy and safety of immediate angioplasty versus ischemia-guided management after thrombolysis in acute myocardial infarction in areas with very long transfer distances results of the NORDISTEMI [trunc]. J Am Coll Cardiol. 2010 Jan 12;55(2):102-10. PubMed

Bonnefoy E, Lapostolle F, Leizorovicz A, Steg G, McFadden EP, Dubien PY, Cattan S, Boullenger E, Machecourt J, Lacroute JM, Cassagnes J, Dissait F, Touboul P. Primary angioplasty versus prehospital fibrinolysis in acute myocardial infarction: a randomised study. Lancet. 2002 Sep 14;360(9336):825-9. [28 references] PubMed

Borgia F, Goodman SG, Halvorsen S, Cantor WJ, Piscione F, Le May MR, Fernandez-Aviles F, Sanchez PL, Dimopoulos K, Scheller B, Armstrong PW, Di Mario C. Early routine percutaneous coronary intervention after fibrinolysis vs. standard therapy in ST-segment elevation myocardial infarction: a meta-analysis. Eur Heart J. 2010 Sep;31(17):2156-69. PubMed

Bradley EH, Herrin J, Wang Y, Barton BA, Webster TR, Mattera JA, Roumanis SA, Curtis JP, Nallamothu BK, Magid DJ, McNamara RL, Parkosewich J, Loeb JM, Krumholz HM. Strategies for reducing the door-to-balloon time in acute myocardial infarction. N Engl J Med. 2006 Nov 30;355(22):2308-20. PubMed

Brieger D, Eagle KA, Goodman SG, Steg PG, Budaj A, White K, Montalescot G. Acute coronary syndromes without chest pain, an underdiagnosed and undertreated high-risk group: insights from the Global Registry of Acute Coronary Events. 2004. Chest. 2009 Nov;136(5 Suppl):e30. PubMed

Burzotta F, De Vita M, Gu YL, Isshiki T, Lefevre T, Kaltoft A, Dudek D, Sardella G, Orrego PS, Antoniucci D, De Luca L, Biondi-Zoccai GG, Crea F, Zijlstra F. Clinical impact of thrombectomy in acute ST-elevation myocardial infarction: an individual patient-data pooled analysis of 11 trials. Eur Heart J. 2009 Sep;30(18):2193-203. [41 references] PubMed

Cantor WJ, Fitchett D, Borgundvaag B, Ducas J, Heffernan M, Cohen EA, Morrison LJ, Langer A, Dzavik V, Mehta SR, Lazzam C, Schwartz B, Casanova A, Goodman SG, TRANSFER-AMI Trial Investigators. Routine early angioplasty after fibrinolysis for acute myocardial infarction. N Engl J Med. 2009 Jun 25;360(26):2705-18. PubMed

CAPRIE Steering Committee. A randomised, blinded, trial of clopidogrel versus aspirin in patients at risk of ischaemic events (CAPRIE). Lancet. 1996 Nov 16;348(9038):1329-39. PubMed

Chen ZM, Jiang LX, Chen YP, Xie JX, Pan HC, Peto R, Collins R, Liu LS, COMMIT (ClOpidogrel and Metoprolol in Myocardial Infarction Trial) collaborative . Addition of clopidogrel to aspirin in 45,852 patients with acute myocardial infarction: randomised placebo-controlled trial. Lancet. 2005 Nov 5;366(9497):1607-21. PubMed

Chen ZM, Pan HC, Chen YP, Peto R, Collins R, Jiang LX, Xie JX, Liu LS. Early intravenous then oral metoprolol in 45,852 patients with acute myocardial infarction: randomised placebo-controlled trial. Lancet. 2005 Nov 5;366(9497):1622-32. PubMed

Costanzo MR, Guglin ME, Saltzberg MT, Jessup ML, Bart BA, Teerlink JR, Jaski BE, Fang JC, Feller ED, Haas GJ, Anderson AS, Schollmeyer MP, Sobotka PA, UNLOAD Trial Investigators. Ultrafiltration versus intravenous diuretics for patients hospitalized for acute decompensated heart failure. J Am Coll Cardiol. 2007 Feb 13;49(6):675-83. PubMed

Cucherat M, Bonnefoy E, Tremeau G. Primary angioplasty versus intravenous thrombolysis for acute myocardial infarction. Cochrane Database Syst Rev. 2003;(3):CD001560. [53 references] PubMed

Dargie HJ. Effect of carvedilol on outcome after myocardial infarction in patients with left-ventricular dysfunction: the CAPRICORN randomised trial. Lancet. 2001 May 5;357(9266):1385-90. PubMed

De Backer D, Biston P, Devriendt J, Madl C, Chochrad D, Aldecoa C, Brasseur A, Defrance P, Gottignies P, Vincent JL, SOAP II

Investigators. Comparison of dopamine and norepinephrine in the treatment of shock. N Engl J Med. 2010 Mar 4;362(9):779-89. PubMed

De Caterina R, Madonna R, Sourij H, Wascher T. Glycaemic control in acute coronary syndromes: prognostic value and therapeutic options. Eur Heart J. 2010 Jul;31(13):1557-64. PubMed

De Luca G, Bellandi F, Huber K, Noc M, Petronio AS, Arntz HR, Maioli M, Gabriel HM, Zorman S, DE Carlo M, Rakowski T, Gyongyosi M, Dudek D. Early glycoprotein IIb-IIIa inhibitors in primary angioplasty-abciximab long-term results (EGYPT-ALT) cooperation: individual patient's data meta-analysis. J Thromb Haemost. 2011 Dec;9(12):2361-70. PubMed

De Luca G, Dirksen MT, Spaulding C, Kelbaek H, Schalij M, Thuesen L, van der Hoeven B, Vink MA, Kaiser C, Musto C, Chechi T, Spaziani G, Diaz de la Llera LS, Pasceri V, Di Lorenzo E, Violini R, Cortese G, Suryapranata H, Stone GW, Drug-Eluting Stent in Primary Angioplasty (DESERT) Cooperation. Drug-eluting vs bare-metal stents in primary angioplasty: a pooled patient-level meta-analysis of randomized trials. Arch Intern Med. 2012 Apr 23;172(8):611-21; discussion 621-2. PubMed

De Luca G, Suryapranata H, Stone GW, Antoniucci D, Tcheng JE, Neumann FJ, Van de Werf F, Antman EM, Topol EJ. Abciximab as adjunctive therapy to reperfusion in acute ST-segment elevation myocardial infarction: a meta-analysis of randomized trials. JAMA. 2005 Apr 13;293(14):1759-65. PubMed

Di Mario C, Dudek D, Piscione F, Mielecki W, Savonitto S, Murena E, Dimopoulos K, Manari A, Gaspardone A, Ochala A, Zmudka K, Bolognese L, Steg PG, Flather M, CARESS-in-AMI (Combined Abciximab RE-teplase Stent Study in Acute Myocardial) Investigators. Immediate angioplasty versus standard therapy with rescue angioplasty after thrombolysis in the Combined Abciximab REteplase Stent Study in Acute Myocardial Infarction (CARESS-in-AMI): an open, prospective, randomised, multicentre trial. Lancet. 2008 Feb 16;371(9612):559-68. PubMed

Diaz R, Goyal A, Mehta SR, Afzal R, Xavier D, Pais P, Chrolavicius S, Zhu J, Kazmi K, Liu L, Budaj A, Zubaid M, Avezum A, Ruda M, Yusuf S. Glucose-insulin-potassium therapy in patients with ST-segment elevation myocardial infarction. JAMA. 2007 Nov 28;298(20):2399-405. PubMed

Dickstein K, Cohen-Solal A, Filippatos G, McMurray JJ, Ponikowski P, Poole-Wilson PA, Stromberg A, van Veldhuisen DJ, Atar D, Hoes AW, Keren A, Mebazaa A, Nieminen M, Priori SG, Swedberg K, ESC Committee for Practice Guidelines (CPG), Vahanian A, Camm J, De Caterina R, Dean V, Dickstein K, Filippatos G, Funck-Brentano C, Hellemans I, Kristensen SD, McGregor K, Sechtem U, Silber S, Tendera M, Widimsky P, Zamorano JL, Document Reviewers, Tendera M, Auricchio A, Bax J, Bohm M, Corra U, Della Bella P, Elliott PM, Follath F, Gheorghiade M, Hasin Y, Hernborg A, Jaarsma T, Komajda M, Kornowski R, Piepoli M, Prendergast B, Tavazzi L, Vachiery JL, Verheugt FW, Zamorano JL, Zannad F. ESC guidelines for the diagnosis and treatment of acute and chronic heart failure 2008: the Task Force [trunc]. Eur Heart J. 2008 Oct;29(19):2388-442. [252 references] PubMed

Dickstein K, Kjekshus J, OPTIMAAL Steering Committee of the OPTIMAAL Study Group. Effects of losartan and captopril on mortality and morbidity in high-risk patients after acute myocardial infarction: the OPTIMAAL randomised trial. Optimal Trial in Myocardial Infarction with Angiotensin II Antagonist Losartan. Lancet. 2002 Sep 7;360(9335):752-60. PubMed

Diercks DB, Peacock WF, Hiestand BC, Chen AY, Pollack CV Jr, Kirk JD, Smith SC Jr, Gibler WB, Ohman EM, Blomkalns AL, Newby LK, Hochman JS, Peterson ED, Roe MT. Frequency and consequences of recording an electrocardiogram >10 minutes after arrival in an emergency room in non-ST-segment elevation acute coronary syndromes (from the CRUSADE Initiative). Am J Cardiol. 2006 Feb 15;97(4):437-42. PubMed

Effect of ramipril on mortality and morbidity of survivors of acute myocardial infarction with clinical evidence of heart failure. The Acute Infarction Ramipril Efficacy (AIRE) Study Investigators. Lancet. 1993 Oct 2;342(8875):821-8. PubMed

Ellis SG, da Silva ER, Heyndrickx G, Talley JD, Cernigliaro C, Steg G, Spaulding C, Nobuyoshi M, Erbel R, Vassanelli C, et al. Randomized comparison of rescue angioplasty with conservative management of patients with early failure of thrombolysis for acute anterior myocardial infarction. Circulation. 1994 Nov;90(5):2280-4. PubMed

Ellis SG, Tendera M, de Belder MA, van Boven AJ, Widimsky P, Janssens L, Andersen HR, Betriu A, Savonitto S, Adamus J, Peruga JZ, Kosmider M, Katz O, Neunteufl T, Jorgova J, Dorobantu M, Grinfeld L, Armstrong P, Brodie BR, Herrmann HC, Montalescot G, Neumann FJ, Effron MB, Barnathan ES, Topol EJ, FINESSE Investigators. Facilitated PCI in patients with ST-elevation myocardial infarction. N Engl J Med. 2008 May 22;358(21):2205-17. PubMed

European Association for Cardiovascular Prevention & Rehabilitation, Reiner Z, Catapano AL, De Backer G, Graham I, Taskinen MR, Wiklund O, Agewall S, Alegria E, Chapman MJ, Durrington P, Erdine S, Halcox J, Hobbs R, Kjekshus J, Filardi PP, Riccardi G, Storey RF, Wood D, ESC Committee for Practice Guidelines (CPG) 2008-2010 and 2010-2012 Committees. ESC/EAS guidelines for the management of dyslipidaemias: the Task Force for the management of dyslipidaemias of the European Society of Cardiology (ESC) and the European Atherosclerosis Society (EAS). Eur Heart J. 2011 Jul;32(14):1769-818. PubMed

European Heart Rhythm Association, European Association for Cardio-Thoracic Surgery, Camm AJ, Kirchhof P, Lip GY, Schotten U, Savelieva I, Ernst S, Van Gelder IC, Al-Attar N, Hindricks G, Prendergast B, Heidbuchel H, Alfieri O, Angelini A, Atar D, Colonna P, De Caterina R, De Sutter J, Goette A, Gorenek B, Heldal M, Hohloser SH, Kolh P, Le Heuzey JY, Ponikowski P, Rutten FH. Guidelines for the management of atrial fibrillation: the Task Force for the Management of Atrial Fibrillation of the European Society of Cardiology (ESC). Eur Heart J. 2010 Oct;31(19):2369-429. PubMed

Fernandez-Aviles F, Alonso JJ, Castro-Beiras A, Vazquez N, Blanco J, Alonso-Briales J, Lopez-Mesa J, Fernandez-Vazquez F, Calvo I, Martinez-Elbal L, San Roman JA, Ramos B. Routine invasive strategy within 24 hours of thrombolysis versus ischaemia-guided conservative approach for acute myocardial infarction with ST-segment elevation (GRACIA-1): a randomised controlled trial. Lancet. 2004 Sep 18-24;364(9439):1045-53. PubMed

Fox KM. Efficacy of perindopril in reduction of cardiovascular events among patients with stable coronary artery disease: randomised, double-blind, placebo-controlled, multicentre trial (the EUROPA study). Lancet. 2003 Sep 6;362(9386):782-8. PubMed

Garot P, Lefevre T, Eltchaninoff H, Morice MC, Tamion F, Abry B, Lesault PF, Le Tarnec JY, Pouges C, Margenet A, Monchi M, Laurent I, Dumas P, Garot J, Louvard Y. Six-month outcome of emergency percutaneous coronary intervention in resuscitated patients after cardiac arrest complicating ST-elevation myocardial infarction. Circulation. 2007 Mar 20;115(11):1354-62. PubMed

Gershlick AH, Stephens-Lloyd A, Hughes S, Abrams KR, Stevens SE, Uren NG, de Belder A, Davis J, Pitt M, Banning A, Baumbach A, Shiu MF, Schofield P, Dawkins KD, Henderson RA, Oldroyd KG, Wilcox R, REACT Trial Investigators. Rescue angioplasty after failed thrombolytic therapy for acute myocardial infarction. N Engl J Med. 2005 Dec 29;353(26):2758-68. PubMed

Gierlotka M, Gasior M, Wilczek K, Hawranek M, Szkodzinski J, Paczek P, Lekston A, Kalarus Z, Zembala M, Polonski L. Reperfusion by primary percutaneous coronary intervention in patients with ST-segment elevation myocardial infarction within 12 to 24 hours of the onset of symptoms (from a prospective national observational study [PL-ACS]). Am J Cardiol. 2011 Feb 15;107(4):501-8. PubMed

Giraldez RR, Nicolau JC, Corbalan R, Gurfinkel EP, Juarez U, Lopez-Sendon J, Parkhomenko A, Molhoek P, Mohanavelu S, Morrow DA, Antman EM. Enoxaparin is superior to unfractionated heparin in patients with ST elevation myocardial infarction undergoing fibrinolysis regardless of the choice of lytic: an ExTRACT-TIMI 25 analysis. Eur Heart J. 2007 Jul;28(13):1566-73. PubMed

Grines CL, Marsalese DL, Brodie B, Griffin J, Donohue B, Costantini CR, Balestrini C, Stone G, Wharton T, Esente P, Spain M, Moses J, Nobuyoshi M, Ayres M, Jones D, Mason D, Sachs D, Grines LL, O'Neill W. Safety and cost-effectiveness of early discharge after primary angioplasty in low risk patients with acute myocardial infarction. PAMI-II Investigators. Primary Angioplasty in Myocardial Infarction. J Am Coll Cardiol. 1998 Apr;31(5):967-72. PubMed

Gwon HC, Hahn JY, Park KW, Song YB, Chae IH, Lim DS, Han KR, Choi JH, Choi SH, Kang HJ, Koo BK, Ahn T, Yoon JH, Jeong MH, Hong TJ, Chung WY, Choi YJ, Hur SH, Kwon HM, Jeon DW, Kim BO, Park SH, Lee NH, Jeon HK, Jang Y, Kim HS. Six-month versus 12-month dual antiplatelet therapy after implantation of drug-eluting stents: the Efficacy of Xience/Promus Versus Cypher to Reduce Late Loss After Stenting (EXCELLENT) randomized, multicenter study. Circulation. 2012 Jan 24;125(3):505-13. PubMed

Hannan EL, Samadashvili Z, Walford G, Holmes DR Jr, Jacobs AK, Stamato NJ, Venditti FJ, Sharma S, King SB 3rd. Culprit vessel percutaneous coronary intervention versus multivessel and staged percutaneous coronary intervention for ST-segment elevation myocardial infarction patients with multivessel disease. JACC Cardiovasc Interv. 2010 Jan;3(1):22-31. PubMed

Heran BS, Chen JM, Ebrahim S, Moxham T, Oldridge N, Rees K, Thompson DR, Taylor RS. Exercise-based cardiac rehabilitation for coronary heart disease. Cochrane Database Syst Rev. 2011;(7):CD001800. PubMed

Herrmann HC, Lu J, Brodie BR, Armstrong PW, Montalescot G, Betriu A, Neuman FJ, Effron MB, Barnathan ES, Topol EJ, Ellis SG, FINESSE Investigators. Benefit of facilitated percutaneous coronary intervention in high-risk ST-segment elevation myocardial infarction patients presenting to nonpercutaneous coronary intervention hospitals. JACC Cardiovasc Interv. 2009 Oct;2(10):917-24. PubMed

Hochman JS, Lamas GA, Buller CE, Dzavik V, Reynolds HR, Abramsky SJ, Forman S, Ruzyllo W, Maggioni AP, White H, Sadowski Z, Carvalho AC, Rankin JM, Renkin JP, Steg PG, Mascette AM, Sopko G, Pfisterer ME, Leor J, Fridrich V, Mark DB, Knatterud GL, Occluded Artery Trial Investigators. Coronary intervention for persistent occlusion after myocardial infarction. N Engl J Med. 2006 Dec 7;355(23):2395-407. PubMed

Hochman JS, Sleeper LA, Webb JG, Sanborn TA, White HD, Talley JD, Buller CE, Jacobs AK, Slater JN, Col J, McKinlay SM, LeJemtel TH. Early revascularization in acute myocardial infarction complicated by cardiogenic shock. SHOCK Investigators. Should We Emergently Revascularize Occluded Coronaries for Cardiogenic Shock. N Engl J Med. 1999 Aug 26;341(9):625-34. PubMed

Hochman JS, Sleeper LA, White HD, Dzavik V, Wong SC, Menon V, Webb JG, Steingart R, Picard MH, Menegus MA, Boland J, Sanborn T, Buller CE, Modur S, Forman R, Desvigne-Nickens P, Jacobs AK, Slater JN, LeJemtel TH, SHOCK Investigators. One-year survival following early revascularization for cardiogenic shock. JAMA. 2001 Jan 10;285(2):190-2. PubMed

Hou ZY, Chang MS, Chen CY, Tu MS, Lin SL, Chiang HT, Woosley RL. Acute treatment of recent-onset atrial fibrillation and flutter with a tailored dosing regimen of intravenous amiodarone. A randomized, digoxin-controlled study. Eur Heart J. 1995 Apr;16(4):521-8. PubMed

Huikuri HV, Cox M, Interian A Jr, Kessler KM, Glicksman F, Castellanos A, Myerburg RJ. Efficacy of intravenous propranolol for suppression of inducibility of ventricular tachyarrhythmias with different electrophysiologic characteristics in coronary artery disease. Am J Cardiol. 1989 Dec 1;64(19):1305-9. PubMed

Hypothermia after Cardiac Arrest Study Group. Mild therapeutic hypothermia to improve the neurologic outcome after cardiac arrest [erratum in: N Engl J Med 2002 May 30;346(22):1756.]. New Eng J Med. 2002 Feb 21;346(8):549-56. PubMed

Ioannidis JP, Katritsis DG. Percutaneous coronary intervention for late reperfusion after myocardial infarction in stable patients. Am Heart J. 2007 Dec;154(6):1065-71. PubMed

ISIS-4: a randomised factorial trial assessing early oral captopril, oral mononitrate, and intravenous magnesium sulphate in 58,050 patients with suspected acute myocardial infarction. ISIS-4 (Fourth International Study of Infarct Survival) Collabora. Lancet. 1995 Mar 18;345(8951):669-85. PubMed

Jolly SS, Yusuf S, Cairns J, Niemela K, Xavier D, Widimsky P, Budaj A, Niemela M, Valentin V, Lewis BS, Avezum A, Steg PG, Rao SV, Gao P, Afzal R, Joyner CD, Chrolavicius S, Mehta SR, RIVAL trial group. Radial versus femoral access for coronary angiography and intervention in patients with acute coronary syndromes (RIVAL): a randomised, parallel group, multicentre trial. Lancet. 2011 Apr 23;377(9775):1409-20. PubMed

Kalla K, Christ G, Karnik R, Malzer R, Norman G, Prachar H, Schreiber W, Unger G, Glogar HD, Kaff A, Laggner AN, Maurer G, Mlczoch J, Slany J, Weber HS, Huber K. Implementation of guidelines improves the standard of care: the Viennese registry on reperfusion strategies in ST-elevation myocardial infarction (Vienna STEMI Registry). Circulation. 2006;113(20):2398-405. PubMed

Kastrati A, Dibra A, Spaulding C, Laarman GJ, Menichelli M, Valgimigli M, Di Lorenzo E, Kaiser C, Tierala I, Mehilli J, Seyfarth M, Varenne O, Dirksen MT, Percoco G, Varricchio A, Pittl U, Syvanne M, Suttorp MJ, Violini R, Schomig A. Meta-analysis of randomized trials on drug-eluting stents vs. bare-metal stents in patients with acute myocardial infarction. Eur Heart J. 2007 Nov;28(22):2706-13. [38 references] PubMed

Keeley EC, Boura JA, Grines CL. Primary angioplasty versus intravenous thrombolytic therapy for acute myocardial infarction: a quantitative review of 23 randomised trials. Lancet. 2003 Jan 4;361(9351):13-20. [41 references] PubMed

Keeley EC, Hillis LD. Left ventricular mural thrombus after acute myocardial infarction. Clin Cardiol. 1996 Feb;19(2):83-6. [26 references] PubMed

Kelbaek H, Terkelsen CJ, Helqvist S, Lassen JF, Clemmensen P, Klovgaard L, Kaltoft A, Engstrom T, Botker HE, Saunamaki K, Krusell LR, Jorgensen E, Hansen HH, Christiansen EH, Ravkilde J, Kober L, Kofoed KF, Thuesen L. Randomized comparison of distal protection versus conventional treatment in primary percutaneous coronary intervention: the drug elution and distal protection in ST-elevation myocardial infarction (DEDICATION) trial. J Am Coll Cardiol. 2008 Mar 4;51(9):899-905. PubMed

Kern KB, Rahman O. Emergent percutaneous coronary intervention for resuscitated victims of out-of-hospital cardiac arrest. Catheter Cardiovasc Interv. 2010 Mar 1;75(4):616-24. [26 references] PubMed

Knot J, Widimsky P, Wijns W, Stenestrand U, Kristensen SD, Van' T Hof A, Weidinger F, Janzon M, Norgaard BL, Soerensen JT, van de Wetering H, Thygesen K, Bergsten PA, Digerfeldt C, Potgieter A, Tomer N, Fajadet J. How to set up an effective national primary angioplasty network: lessons learned from five European countries. EuroIntervention. 2009 Aug;5(3):299, 301-309. PubMed

Kober L, Torp-Pedersen C, Carlsen JE, Bagger H, Eliasen P, Lyngborg K, Videbaek J, Cole DS, Auclert L, Pauly NC. A clinical trial of the angiotensin-converting-enzyme inhibitor trandolapril in patients with left ventricular dysfunction after myocardial infarction. Trandolapril Cardiac Evaluation (TRACE) Study Group. N Engl J Med. 1995 Dec 21;333(25):1670-6. PubMed

Kosiborod M, McGuire DK. Glucose-lowering targets for patients with cardiovascular disease: focus on inpatient management of patients with acute coronary syndromes. Circulation. 2010 Dec 21;122(25):2736-44. PubMed

Kotowycz MA, Cosman TL, Tartaglia C, Afzal R, Syal RP, Natarajan MK. Safety and feasibility of early hospital discharge in ST-segment

elevation myocardial infarction--a prospective and randomized trial in low-risk primary percutaneous coronary intervention patients (the Safe-Depart Trial). Am Heart J. 2010 Jan;159(1):117.e1-6. PubMed

Lawler PR, Filion KB, Eisenberg MJ. Efficacy of exercise-based cardiac rehabilitation post-myocardial infarction: a systematic review and meta-analysis of randomized controlled trials. Am Heart J. 2011 Oct;162(4):571-584.e2. PubMed

Lee DS, Green LD, Liu PP, Dorian P, Newman DM, Grant FC, Tu JV, Alter DA. Effectiveness of implantable defibrillators for preventing arrhythmic events and death: a meta-analysis. J Am Coll Cardiol. 2003 May 7;41(9):1573-82. PubMed

Leon MB, Baim DS, Popma JJ, Gordon PC, Cutlip DE, Ho KK, Giambartolomei A, Diver DJ, Lasorda DM, Williams DO, Pocock SJ, Kuntz RE. A clinical trial comparing three antithrombotic-drug regimens after coronary-artery stenting. Stent Anticoagulation Restenosis Study Investigators. N Engl J Med. 1998 Dec 3;339(23):1665-71. PubMed

Levy B, Perez P, Perny J, Thivilier C, Gerard A. Comparison of norepinephrine-dobutamine to epinephrine for hemodynamics, lactate metabolism, and organ function variables in cardiogenic shock. A prospective, randomized pilot study. Crit Care Med. 2011 Mar;39(3):450-5. PubMed

McAlister FA, Stewart S, Ferrua S, McMurray JJ. Multidisciplinary strategies for the management of heart failure patients at high risk for admission: a systematic review of randomized trials. J Am Coll Cardiol. 2004 Aug 18;44(4):810-9. [46 references] PubMed

Mega JL, Braunwald E, Wiviott SD, Bassand JP, Bhatt DL, Bode C, Burton P, Cohen M, Cook-Bruns N, Fox KA, Goto S, Murphy SA, Plotnikov AN, Schneider D, Sun X, Verheugt FW, Gibson CM, ATLAS ACS 2-TIMI 51 Investigators. Rivaroxaban in patients with a recent acute coronary syndrome. N Engl J Med. 2012 Jan 5;366(1):9-19. PubMed

Mehta RH, Starr AZ, Lopes RD, Hochman JS, Widimsky P, Pieper KS, Armstrong PW, Granger CB, APEX AMI Investigators. Incidence of and outcomes associated with ventricular tachycardia or fibrillation in patients undergoing primary percutaneous coronary intervention. JAMA. 2009 May 6;301(17):1779-89. PubMed

Menon V, Pearte CA, Buller CE, Steg PG, Forman SA, White HD, Marino PN, Katritsis DG, Caramori P, Lasevitch R, Loboz-Grudzien K, Zurakowski A, Lamas GA, Hochman JS. Lack of benefit from percutaneous intervention of persistently occluded infarct arteries after the acute phase of myocardial infarction is time independent: insights from Occluded Artery Trial. Eur Heart J. 2009 Jan;30(2):183-91. PubMed

Montalescot G, Zeymer U, Silvain J, Boulanger B, Cohen M, Goldstein P, Ecollan P, Combes X, Huber K, Pollack C Jr, Benezet JF, Stibbe O, Filippi E, Teiger E, Cayla G, Elhadad S, Adnet F, Chouihed T, Gallula S, Greffet A, Aout M, Collet JP, Vicaut E, ATOLL Investigators. Intravenous enoxaparin or unfractionated heparin in primary percutaneous coronary intervention for ST-elevation myocardial infarction: the international randomised open-label ATOLL trial. Lancet. 2011 Aug 20;378(9792):693-703. PubMed

Morrison LJ, Verbeek PR, McDonald AC, Sawadsky BV, Cook DJ. Mortality and prehospital thrombolysis for acute myocardial infarction: A meta-analysis. JAMA. 2000 May 24-31;283(20):2686-92. PubMed

Nallamothu BK, Krumholz HM, Ko DT, LaBresh KA, Rathore S, Roe MT, Schwamm L. Development of systems of care for ST-elevation myocardial infarction patients: gaps, barriers, and implications. Circulation. 2007 Jul 10;116(2):e68-72. PubMed

Ndrepepa G, Kastrati A, Mehilli J, Antoniucci D, Schomig A. Mechanical reperfusion and long-term mortality in patients with acute myocardial infarction presenting 12 to 48 hours from onset of symptoms. JAMA. 2009 Feb 4;301(5):487-8. PubMed

Newby LK, Hasselblad V, Armstrong PW, Van de Werf F, Mark DB, White HD, Topol EJ, Califf RM. Time-based risk assessment after myocardial infarction. Implications for timing of discharge and applications to medical decision-making. Eur Heart J. 2003 Jan;24(2):182-9. PubMed

NICE-SUGAR Study Investigators, Finfer S, Chittock DR, Su SY, Blair D, Foster D, Dhingra V, Bellomo R, Cook D, Dodek P, Henderson WR, Hebert PC, Heritier S, Heyland DK, McArthur C, McDonald E, Mitchell I, Myburgh JA, Norton R, Potter J, Robinson BG, Ronco JJ. Intensive versus conventional glucose control in critically ill patients. N Engl J Med. 2009 Mar 26;360(13):1283-97. PubMed

Nielsen PH, Terkelsen CJ, Nielsen TT, Thuesen L, Krusell LR, Thayssen P, Kelbaek H, Abildgaard U, Villadsen AB, Andersen HR, Maeng M, Danami-2 Investigators. System delay and timing of intervention in acute myocardial infarction (from the Danish Acute Myocardial Infarction-2 [DANAMI-2] trial). Am J Cardiol. 2011 Sep 15;108(6):776-81. PubMed

Nordmann AJ, Hengstler P, Harr T, Young J, Bucher HC. Clinical outcomes of primary stenting versus balloon angioplasty in patients with myocardial infarction: a meta-analysis of randomized controlled trials. Am J Med. 2004 Feb 15;116(4):253-62. [31 references] PubMed

O'Doherty M, Tayler DI, Quinn E, Vincent R, Chamberlain DA. Five hundred patients with myocardial infarction monitored within one hour of symptoms. Br Med J (Clin Res Ed). 1983 Apr 30;286(6375):1405-8. PubMed

Packer M, Coats AJ, Fowler MB, Katus HA, Krum H, Mohacsi P, Rouleau JL, Tendera M, Castaigne A, Roecker EB, Schultz MK, DeMets DL. Effect of carvedilol on survival in severe chronic heart failure. N Engl J Med. 2001 May 31;344(22):1651-8. PubMed

Park SJ, Park DW, Kim YH, Kang SJ, Lee SW, Lee CW, Han KH, Park SW, Yun SC, Lee SG, Rha SW, Seong IW, Jeong MH, Hur SH, Lee NH, Yoon J, Yang JY, Lee BK, Choi YJ, Chung WS, Lim DS, Cheong SS, Kim KS, Chae JK, Nah DY, Jeon DS, Seung KB, Jang JS, Park HS, Lee K. Duration of dual antiplatelet therapy after implantation of drug-eluting stents. N Engl J Med. 2010 Apr 15;362(15):1374-82. PubMed

Patel MR, Smalling RW, Thiele H, Barnhart HX, Zhou Y, Chandra P, Chew D, Cohen M, French J, Perera D, Ohman EM. Intra-aortic balloon counterpulsation and infarct size in patients with acute anterior myocardial infarction without shock: the CRISP AMI randomized trial. JAMA. 2011 Sep 28;306(12):1329-37. PubMed

Patrono C, Andreotti F, Arnesen H, Badimon L, Baigent C, Collet JP, De Caterina R, Gulba D, Huber K, Husted S, Kristensen SD, Morais J, Neumann FJ, Rasmussen LH, Siegbahn A, Steg PG, Storey RF, Van de Werf F, Verheugt F. Antiplatelet agents for the treatment and prevention of atherothrombosis. Eur Heart J. 2011 Dec;32(23):2922-32. PubMed

Peters RJ, Joyner C, Bassand JP, Afzal R, Chrolavicius S, Mehta SR, Oldgren J, Wallentin L, Budaj A, Fox KA, Yusuf S, OASIS-6 investigators. The role of fondaparinux as an adjunct to thrombolytic therapy in acute myocardial infarction: a subgroup analysis of the OASIS-6 trial. Eur Heart J. 2008 Feb;29(3):324-31. PubMed

Pfeffer MA, Braunwald E, Moye LA, Basta L, Brown EJ Jr, Cuddy TE, Davis BR, Geltman EM, Goldman S, Flaker GC, et al. Effect of captopril on mortality and morbidity in patients with left ventricular dysfunction after myocardial infarction. Results of the survival and ventricular enlargement trial. The SAVE Investigators. N Engl J Med. 1992 Sep 3;327(10):669-77. PubMed

Pfeffer MA, McMurray JJ, Velazquez EJ, Rouleau JL, Kober L, Maggioni AP, Solomon SD, Swedberg K, Van de Werf F, White H, Leimberger JD, Henis M, Edwards S, Zelenkofske S, Sellers MA, Califf RM. Valsartan, captopril, or both in myocardial infarction complicated by heart failure, left ventricular dysfunction, or both. N Engl J Med. 2003 Nov 13;349(20):1893-906. PubMed

Piccini JP, Hranitzky PM, Kilaru R, Rouleau JL, White HD, Aylward PE, Van de Werf F, Solomon SD, Califf RM, Velazquez EJ. Relation of mortality to failure to prescribe beta blockers acutely in patients with sustained ventricular tachycardia and ventricular fibrillation following acute myocardial infarction (from the VALsartan in Acute myocardial iNfarcTion trial) [trunc]. Am J Cardiol. 2008 Dec 1;102(11):1427-32. PubMed

Piccini JP, Schulte PJ, Pieper KS, Mehta RH, White HD, Van de Werf F, Ardissino D, Califf RM, Granger CB, Ohman EM, Alexander JH. Antiarrhythmic drug therapy for sustained ventricular arrhythmias complicating acute myocardial infarction. Crit Care Med. 2011 Jan;39(1):78-83. PubMed

Pinto DS, Kirtane AJ, Nallamothu BK, Murphy SA, Cohen DJ, Laham RJ, Cutlip DE, Bates ER, Frederick PD, Miller DP, Carrozza JP Jr, Antman EM, Cannon CP, Gibson CM. Hospital delays in reperfusion for ST-elevation myocardial infarction: implications when selecting a reperfusion strategy. Circulation. 2006 Nov 7;114(19):2019-25. PubMed

Pitt B, Remme W, Zannad F, Neaton J, Martinez F, Roniker B, Bittman R, Hurley S, Kleiman J, Gatlin M. Eplerenone, a selective aldosterone blocker, in patients with left ventricular dysfunction after myocardial infarction. N Engl J Med. 2003 Apr 3;348(14):1309-21. PubMed

Pitt B, Zannad F, Remme WJ, Cody R, Castaigne A, Perez A, Palensky J, Wittes J. The effect of spironolactone on morbidity and mortality in patients with severe heart failure. Randomized Aldactone Evaluation Study Investigators. New Eng J Med. 1999 Sep 2;341(10):709-17. PubMed

Poole-Wilson PA, Swedberg K, Cleland JG, Di Lenarda A, Hanrath P, Komajda M, Lubsen J, Lutiger B, Metra M, Remme WJ, Torp-Pedersen C, Scherhag A, Skene A. Comparison of carvedilol and metoprolol on clinical outcomes in patients with chronic heart failure in the Carvedilol Or Metoprolol European Trial (COMET): randomised controlled trial. Lancet. 2003 Jul 5;362(9377):7-13. PubMed

Randomised trial of intravenous streptokinase, oral aspirin, both, or neither among 17,187 cases of suspected acute myocardial infarction: ISIS-2. ISIS-2 (Second International Study of Infarct Survival) Collaborative Group. Lancet. 1988 Aug 13;2(8607):349-60. PubMed

Rathore SS, Curtis JP, Chen J, Wang Y, Nallamothu BK, Epstein AJ, Krumholz HM, National Cardiovascular Data Registry. Association of door-to-balloon time and mortality in patients admitted to hospital with ST elevation myocardial infarction: national cohort study. BMJ. 2009;338:b1807. PubMed

Reeder GS, Lengyel M, Tajik AJ, Seward JB, Smith HC, Danielson GK. Mural thrombus in left ventricular aneurysm: incidence, role of angiography, and relation between anticoagulation and embolization. Mayo Clin Proc. 1981 Feb;56(2):77-81. PubMed

Rokos IC, French WJ, Koenig WJ, Stratton SJ, Nighswonger B, Strunk B, Jewell J, Mahmud E, Dunford JV, Hokanson J, Smith SW, Baran KW, Swor R, Berman A, Wilson BH, Aluko AO, Gross BW, Rostykus PS, Salvucci A, Dev V, McNally B, Manoukian SV, King SB 3rd. Integration of pre-hospital electrocardiograms and ST-elevation myocardial infarction receiving center (SRC) networks: impact on Door-to-Balloon times across 10 independent regions. JACC Cardiovasc Interv. 2009 Apr;2(4):339-46. PubMed

Romagnoli E, Biondi-Zoccai G, Sciahbasi A, Politi L, Rigattieri S, Pendenza G, Summaria F, Patrizi R, Borghi A, Di Russo C, Moretti C, Agostoni P, Loschiavo P, Lioy E, Sheiban I, Sangiorgi G. Radial versus femoral randomized investigation in ST-segment elevation acute coronary syndrome: the RIFLE-STEACS (Radial Versus Femoral Randomized Investigation in ST-Elevation Acute Coronary Syndrome) study. J Am Coll Cardiol. 2012 Dec 18;60(24):2481-9. PubMed

Ross AM, Molhoek P, Lundergan C, Knudtson M, Draoui Y, Regalado L, Le Louer V, Bigonzi F, Schwartz W, de Jong E, Coyne K, HART

II Investigators. Randomized comparison of enoxaparin, a low-molecular-weight heparin, with unfractionated heparin adjunctive to recombinant tissue plasminogen activator thrombolysis and aspirin: second trial of Heparin and Aspirin Reperfusion Therapy (HART II). Circulation. 2001 Aug 7;104(6):648-52. PubMed

Sabatine MS, Cannon CP, Gibson CM, Lopez-Sendon JL, Montalescot G, Theroux P, Claeys MJ, Cools F, Hill KA, Skene AM, McCabe CH, Braunwald E. Addition of clopidogrel to aspirin and fibrinolytic therapy for myocardial infarction with ST-segment elevation. N Engl J Med. 2005 Mar 24;352(12):1179-89. PubMed

Schomig A, Mehilli J, Antoniucci D, Ndrepepa G, Markwardt C, Di Pede F, Nekolla SG, Schlotterbeck K, Schuhlen H, Pache J, Seyfarth M, Martinoff S, Benzer W, Schmitt C, Dirschinger J, Schwaiger M, Kastrati A, Beyond 12 hours Reperfusion AlternatiVe Evaluation (BRAVE-2) Trial Investigators. Mechanical reperfusion in patients with acute myocardial infarction presenting more than 12 hours from symptom onset: a randomized controlled trial. JAMA. 2005 Jun 15;293(23):2865-72. PubMed

Schomig A, Neumann FJ, Kastrati A, Schuhlen H, Blasini R, Hadamitzky M, Walter H, Zitzmann-Roth EM, Richardt G, Alt E, Schmitt C, Ulm K. A randomized comparison of antiplatelet and anticoagulant therapy after the placement of coronary-artery stents. N Engl J Med. 1996 Apr 25;334(17):1084-9. PubMed

Secondary prevention with verapamil after myocardial infarction. The Danish Study Group on Verapamil in Myocardial Infarction. Am J Cardiol. 1990 Dec 18;66(21):33I-40I. PubMed

Segal JB, McNamara RL, Miller MR, Kim N, Goodman SN, Powe NR, Robinson K, Yu D, Bass EB. The evidence regarding the drugs used for ventricular rate control. J Fam Pract. 2000 Jan;49(1):47-59. [67 references] PubMed

Shah MR, Hasselblad V, Stevenson LW, Binanay C, O'Connor CM, Sopko G, Califf RM. Impact of the pulmonary artery catheter in critically ill patients: meta-analysis of randomized clinical trials. JAMA. 2005 Oct 5;294(13):1664-70. PubMed

Sjauw KD, Engstrom AE, Vis MM, van der Schaaf RJ, Baan J Jr, Koch KT, de Winter RJ, Piek JJ, Tijssen JG, Henriques JP. A systematic review and meta-analysis of intra-aortic balloon pump therapy in ST-elevation myocardial infarction: should we change the guidelines. Eur Heart J. 2009 Feb;30(4):459-68. [43 references] PubMed

Spaulding CM, Joly LM, Rosenberg A, Monchi M, Weber SN, Dhainaut JF, Carli P. Immediate coronary angiography in survivors of out-of-hospital cardiac arrest. N Engl J Med. 1997 Jun 5;336(23):1629-33. PubMed

St John Sutton M, Pfeffer MA, Plappert T, Rouleau JL, Moye LA, Dagenais GR, Lamas GA, Klein M, Sussex B, Goldman S, et al. Quantitative two-dimensional echocardiographic measurements are major predictors of adverse cardiovascular events after acute myocardial infarction. The protective effects of captopril. Circulation. 1994 Jan;89(1):68-75. PubMed

Steg PG, Bonnefoy E, Chabaud S, Lapostolle F, Dubien PY, Cristofini P, Leizorovicz A, Touboul P. Impact of time to treatment on mortality after prehospital fibrinolysis or primary angioplasty: data from the CAPTIM randomized clinical trial. Circulation. 2003 Dec 9;108(23):2851-6. PubMed

Steg PG, Cambou JP, Goldstein P, Durand E, Sauval P, Kadri Z, Blanchard D, Lablanche JM, Gueret P, Cottin Y, Juliard JM, Hanania G, Vaur L, Danchin N, USIC 2000 Investigators. Bypassing the emergency room reduces delays and mortality in ST elevation myocardial infarction: the USIC 2000 registry. Heart. 2006 Oct;92(10):1378-83. PubMed

Steinhubl SR, Berger PB, Mann JT 3rd, Fry ET, DeLago A, Wilmer C, Topol EJ, CREDO Investigators. Clopidogrel for the Reduction of Events During Observation. Early and sustained dual oral antiplatelet therapy following percutaneous coronary intervention: a randomized controlled trial. JAMA. 2002 Nov 20;288(19):2411-20. PubMed

Stone GW, Brodie BR, Griffin JJ, Costantini C, Morice MC, St Goar FG, Overlie PA, Popma JJ, McDonnell J, Jones D, O'Neill WW, Grines CL. Clinical and angiographic follow-Up after primary stenting in acute myocardial infarction: the Primary Angioplasty in Myocardial Infarction (PAMI) stent pilot trial. Circulation. 1999 Mar 30;99(12):1548-54. PubMed

Stone GW, Witzenbichler B, Guagliumi G, Peruga JZ, Brodie BR, Dudek D, Kornowski R, Hartmann F, Gersh BJ, Pocock SJ, Dangas G, Wong SC, Fahy M, Parise H, Mehran R, HORIZONS-AMI Trial Investigators. Heparin plus a glycoprotein IIb/IIIa inhibitor versus bivalirudin monotherapy and paclitaxel-eluting stents versus bare-metal stents in acute myocardial infarction (HORIZONS-AMI): final 3-year results from a multicentre, randomised controlled trial. Lancet. 2011 Jun 25;377(9784):2193-204. PubMed

Stone GW, Witzenbichler B, Guagliumi G, Peruga JZ, Brodie BR, Dudek D, Kornowski R, Hartmann F, Gersh BJ, Pocock SJ, Dangas G, Wong SC, Kirtane AJ, Parise H, Mehran R. Bivalirudin during primary PCI in acute myocardial infarction. N Engl J Med. 2008 May 22;358(21):2218-30. [30 references] PubMed

Svilaas T, Vlaar PJ, van der Horst IC, Diercks GF, de Smet BJ, van den Heuvel AF, Anthonio RL, Jessurun GA, Tan ES, Suurmeijer AJ, Zijlstra F. Thrombus aspiration during primary percutaneous coronary intervention. N Engl J Med. 2008 Feb 7;358(6):557-67. PubMed

Task Force on Myocardial Revascularization of the European Society of Cardiology (ESC), and the European Association for Cardio-Thoracic Surgery (EACTS), European Association for Percutaneous Cardiovascular Interventions, Wijns W, Kolh P, Danchin N, Di Mario C, Falk V, et al. Guidelines on myocardial revascularization. Eur Heart J. 2010 Oct;31(20):2501-55. PubMed

Taylor AL, Ziesche S, Yancy C, Carson P, D'Agostino R Jr, Ferdinand K, Taylor M, Adams K, Sabolinski M, Worcel M, Cohn JN. Combination of isosorbide dinitrate and hydralazine in blacks with heart failure. N Engl J Med. 2004 Nov 11;351(20):2049-57. PubMed

The Cardiac Insufficiency Bisoprolol Study II (CIBIS-II): a randomised trial. Lancet. 1999 Jan 2;353(9146):9-13. PubMed

Thomson CC, Rigotti NA. Hospital- and clinic-based smoking cessation interventions for smokers with cardiovascular disease. Prog Cardiovasc Dis. 2003 May-Jun;45(6):459-79. [174 references] PubMed

Toma M, Buller CE, Westerhout CM, Fu Y, O'Neill WW, Holmes DR Jr, Hamm CW, Granger CB, Armstrong PW, APEX-AMI Investigators. Non-culprit coronary artery percutaneous coronary intervention during acute ST-segment elevation myocardial infarction: insights from the APEX-AMI trial. Eur Heart J. 2010 Jul;31(14):1701-7. PubMed

Turpie AG, Robinson JG, Doyle DJ, Mulji AS, Mishkel GJ, Sealey BJ, Cairns JA, Skingley L, Hirsh J, Gent M. Comparison of high-dose with low-dose subcutaneous heparin to prevent left ventricular mural thrombosis in patients with acute transmural anterior myocardial infarction. N Engl J Med. 1989 Feb 9;320(6):352-7. PubMed

Valgimigli M, Biondi-Zoccai G, Tebaldi M, van't Hof AW, Campo G, Hamm C, ten Berg J, Bolognese L, Saia F, Danzi GB, Briguori C, Okmen E, King SB, Moliterno DJ, Topol EJ. Tirofiban as adjunctive therapy for acute coronary syndromes and percutaneous coronary intervention: a meta-analysis of randomized trials. Eur Heart J. 2010 Jan;31(1):35-49. PubMed

Valgimigli M, Campo G, Percoco G, Monti M, Ferrari F, Tumscitz C, Zuffi A, Colombo F, Kubbajeh M, Cavazza C, Cangiano E, Tebaldi

M, Minarelli M, Arcozzi C, Scalone A, Frangione A, Borghesi M, Marchesini J, Parrinello G, Ferrari R. Randomized comparison of 6- versus 24-month clopidogrel therap. Am Heart J. 2010 Nov;160(5):804-11. PubMed

Van de Werf F, Bax J, Betriu A, Blomstrom-Lundqvist C, Crea F, Falk V, Filippatos G, Fox K, Huber K, Kastrati A, Rosengren A, Steg PG, Tubaro M, Verheugt F, Weidinger F, Weis M, ESC Committee for Practice Guidelines (CPG), Vahanian A, Camm J, De Caterina R, Dean V, Dickstein K, Funck-Brentano C, Hellemans I, Kristensen SD, McGregor K, Sechtem U, Silber S, Tendera M, Widimsky P, Zamorano JL. Management of acute myocardial infarction in patients presenting with persistent ST-segment elevation: the Task Force on the Management of ST-Segment Elevation Acute Myocardial Infarction of the European Society of Cardiology. Eur Heart J. 2008 Dec;29(23):2909-45. [257 references] PubMed

Van't Hof AW, Ten Berg J, Heestermans T, Dill T, Funck RC, van Werkum W, Dambrink JH, Suryapranata H, van Houwelingen G, Ottervanger JP, Stella P, Giannitsis E, Hamm C, Ongoing Tirofiban In Myocardial infarction Evaluation (On-TIME) 2 study group. Prehospital initiation of tirofiban in patients with ST-elevation myocardial infarction undergoing primary angioplasty (On-TIME 2): a multicentre, double-blind, randomised controlled trial. Lancet. 2008 Aug 16;372(9638):537-46. PubMed

Vlaar PJ, Mahmoud KD, Holmes DR Jr, van Valkenhoef G, Hillege HL, van der Horst IC, Zijlstra F, de Smet BJ. Culprit vessel only versus multivessel and staged percutaneous coronary intervention for multivessel disease in patients presenting with ST-segment elevation myocardial infarction: a pairwise and network meta-analysis. J Am Coll Cardiol. 2011 Aug 9;58(7):692-703. PubMed

Vlaar PJ, Svilaas T, van der Horst IC, Diercks GF, Fokkema ML, de Smet BJ, van den Heuvel AF, Anthonio RL, Jessurun GA, Tan ES, Suurmeijer AJ, Zijlstra F. Cardiac death and reinfarction after 1 year in the Thrombus Aspiration during Percutaneous coronary intervention in Acute myocardial infarction Study (TAPAS): a 1-year follow-up study. Lancet. 2008 Jun 7;371(9628):1915-20. PubMed

Wallentin L, Becker RC, Budaj A, Cannon CP, Emanuelsson H, Held C, Horrow J, Husted S, James S, Katus H, Mahaffey KW, Scirica BM, Skene A, Steg PG, Storey RF, Harrington RA, PLATO Investigators, Freij A, Thorsen M. Ticagrelor versus clopidogrel in patients with acute coronary syndromes. N Engl J Med. 2009 Sep 10;361(11):1045-57. PubMed

Wallentin L, Goldstein P, Armstrong PW, Granger CB, Adgey AA, Arntz HR, Bogaerts K, Danays T, Lindahl B, Makijarvi M, Verheugt F, Van de Werf F. Efficacy and safety of tenectepla. Circulation. 2003 Jul 15;108(2):135-42. PubMed

Welsh RC, Chang W, Goldstein P, Adgey J, Granger CB, Verheugt FW, Wallentin L, Van de Werf F, Armstrong PW, ASSENT-3 PLUS Investigators. Time to treatment and the impact of a physician on prehospital management of acute ST elevation myocardial infarction: insights from the ASSENT-3 PLUS trial. Heart. 2005 Nov;91(11):1400-6. PubMed

White HD, Braunwald E, Murphy SA, Jacob AJ, Gotcheva N, Polonetsky L, Antman EM. Enoxaparin vs. unfractionated heparin with fibrinolysis for ST-elevation myocardial infarction in elderly and younger patients: results from ExTRACT-TIMI 25. Eur Heart J. 2007 May;28(9):1066-71. PubMed

Widimsky P, Holmes DR Jr. How to treat patients with ST-elevation acute myocardial infarction and multi-vessel disease. Eur Heart J. 2011 Feb;32(4):396-403. PubMed

Widimsky P, Wijns W, Fajadet J, de Belder M, Knot J, Aaberge L, Andrikopoulos G, Baz JA, Betriu A, Claeys M, Danchin N, Djambazov S, Erne P, Hartikainen J, Huber K, Kala P, Klinceva M, Kristensen SD, Ludman P, Ferre JM, Merkely B, Milicic D, Morais J, Noc M, Opolski G, Ostojic M, Radovanovic D, De Servi S, Stenestrand U, Studencan M, Tubaro M, Vasiljevic Z, Weidinger F, Witkowski A, Zeymer U, European Association for Percutaneous Cardiovascular Interventions. Reperfusion therapy for ST elevation acute myocardial infarction in Europe: description of the current situation in 30 countries. Eur Heart J. 2010 Apr;31(8):943-57. PubMed

Wijnbergen I, Helmes H, Tijssen J, Brueren G, Peels K, van Dantzig JM, Van' t Veer M, Koolen JJ, Pijls NH, Michels R. Comparison of drug-eluting and bare-metal stents for primary percutaneous coronary intervention with or without abciximab in ST-segment elevation myocardial infarction: DEBATER: the Eindhoven reperfusion study. JACC Cardiovasc Interv. 2012 Mar;5(3):313-22. PubMed

Wiviott SD, Braunwald E, McCabe CH, Montalescot G, Ruzyllo W, Gottlieb S, Neumann FJ, Ardissino D, De Servi S, Murphy SA, Riesmeyer J, Weerakkody G, Gibson CM, Antman EM, TRITON-TIMI 38 Investigators. Prasugrel versus clopidogrel in patients with acute coronary syndromes. N Engl J Med. 2007 Nov 15;357(20):2001-15. PubMed

Yusuf S, Mehta SR, Chrolavicius S, Afzal R, Pogue J, Granger CB, Budaj A, Peters RJ, Bassand JP, Wallentin L, Joyner C, Fox KA, OASIS-6 Trial Group. Effects of fondaparinux on mortality and reinfarction in patients with acute ST-segment elevation myocardial infarction: the OASIS-6 randomized trial. JAMA. 2006 Apr 5;295(13):1519-30. PubMed

Yusuf S, Sleight P, Pogue J, Bosch J, Davies R, Dagenais G. Effects of an angiotensin-converting-enzyme inhibitor, ramipril, on cardiovascular events in high-risk patients. The Heart Outcomes Prevention Evaluation Study Investigators. N Engl J Med. 2000 Jan 20;342(3):145-53. PubMed

Zeymer U, Margenet A, Haude M, Bode C, Lablanche JM, Heuer H, Schroder R, Kropff S, Bourkaib R, Banik N, Zahn R, Teiger E. Randomized comparison of eptifibatide versus abciximab in primary percutaneous coronary intervention in patients with acute ST-segment elevation myocardial infarction: results of the EVA-AMI Trial. J Am Coll Cardiol. 2010 Aug 3;56(6):463-9. PubMed

Type of Evidence Supporting the Recommendations

The type of supporting evidence is identified and graded for each recommendation (see the "Major Recommendations" field).

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Appropriate management of patients with acute myocardial infarction presenting with ST-segment elevation

Potential Harms

- Side effects of intravenous opioids include nausea and vomiting, hypotension with bradycardia, and respiratory depression.
- Fibrinolytic therapy is associated with a small but significant excess of strokes, with all of the excess hazard appearing on the first day after treatment. The early strokes are largely attributable to cerebral haemorrhage; later strokes are more frequently thrombotic or embolic. Advanced age, lower weight, female gender, prior cerebrovascular disease, and systolic and diastolic hypertension on admission are significant predictors of intracranial haemorrhage. In the latest trials, intracranial bleeding occurred in 0.9%–1.0% of the total population studied. Major non-cerebral bleeds (bleeding complications requiring blood transfusion or that are life-threatening) can occur in 4%–13% of the patients treated. Administration of streptokinase may be associated with hypotension, but severe allergic reactions are rare. Re-administration of streptokinase should be avoided because of antibodies, which can impair its activity, and because of the risk of allergic reactions.
- Adjunctive anticoagulant, antiplatelet and antithrombotic therapy is associated with a risk of bleeding complications, especially in elderly patients. In patients with severe renal insufficiency (glomerular filtration rate [GFR] <30 mL/min) the infusion dose of tirofiban should be reduced to 50%. In patients with moderate renal insufficiency (GFR 30–59 mL/min) a lower initial infusion rate of 1.4 mg/kg/h should be given.
- Calcium antagonists should be used cautiously or avoided in patients with heart failure because of their negative inotropic effects.
- Intravenous sotalol or other beta-blockers should not be given if ejection fraction (EF) is low.

- Ticagrelor may cause transient dyspnoea at the onset of therapy, which is not associated with morphological or functional lung abnormalities, and which rarely leads to discontinuation. Ticagrelor may also be associated with asymptomatic bradycardia in the first week of therapy. All adenosine diphosphate (ADP) receptor blockers should be used with caution in patients at high risk of bleeding or with significant anaemia.
- In one study, serious hyperkalaemia was more frequent in the group receiving eplerenone compared to placebo.
- There have been concerns about increased risks of very late stent thrombosis and reinfarction with drug-eluting stents (DES), compared with bare-metal stents (BMS). An issue with the routine use of DES in this setting is that it is often difficult to determine reliably the ability of patients to comply with or tolerate the protracted use of dual antiplatelet therapy (DAPT).

Contraindications

Contraindications

- Absolute contraindications to fibrinolytic therapy include previous intracranial haemorrhagic or stroke of unknown origin at any time; ischaemic stroke in preceding 6 months; central nervous system damage or neoplasms, or atrioventricular malformation; recent major trauma, surgery, or head injury (within the preceding 3 weeks); gastrointestinal bleeding within the past month; known bleeding disorders (excluding menses); aortic dissection; non-compressible punctures in the past 24 h (e.g., liver biopsy, lumbar puncture). Relative contraindications include transient ischaemic attack in the preceding 6 months, oral anticoagulant therapy, pregnancy or within 1 week post-partum, refractory hypertension (systolic blood pressure >180 mm Hg and/or diastolic blood pressure >110 mm Hg), advanced liver disease, infective endocarditis, active peptic ulcer, prolonged or traumatic resuscitation.
- Prior streptokinase or anistreplase therapy is a specific contraindication to streptokinase therapy.
- In patients with severe renal insufficiency (glomerular filtration rate [GFR] <30 mL/min) and in dialysis-dependent patients bivalirudin and eptifibatide are contraindicated.
- Beta-blockers are contraindicated in the presence of obstructive airway disease. Early intravenous use of beta-blockers is contraindicated in patients with clinical signs of hypotension or congestive heart failure.
- Intramuscular injections should be avoided.
- Calcium antagonists should be used cautiously or avoided in patients with heart failure because of their negative inotropic effects.
- Prasugrel is contraindicated in patients with prior stroke/transient ischaemic attack (TIA). Its use is generally not recommended in patients aged ≥75 years or in patients with lower body weight (<60 kg) as it was not associated with net clinical benefit in these subsets in one study.

Qualifying Statements

Qualifying Statements

- The European Society of Cardiology (ESC) Guidelines represent the views of the ESC and were arrived at after careful consideration of the available evidence at the time they were written. Health professionals are encouraged to take them fully into account when exercising their clinical judgement. The guidelines do not, however, override the individual responsibility of health professionals to make appropriate decisions in the circumstances of the individual patients, in consultation with that patient, and where appropriate and necessary the patient's guardian or carer. It is also the health professional's responsibility to verify the rules and regulations applicable to drugs and devices at the time of prescription.
- Guidelines are not substitutes, but are complements, for textbooks and cover the ESC Core Curriculum topics. Guidelines and recommendations should help physicians to make decisions in their daily practice. However, the final decisions concerning an individual patient must be made by the responsible physician(s).
- It must be recognized that even when excellent clinical trials have been undertaken, their results are open to interpretation, and that treatment options may be limited by resources. Indeed, cost-effectiveness is becoming an increasingly important issue when deciding upon therapeutic strategies.

Implementation of the Guideline

Description of Implementation Strategy

The task of developing European Society of Cardiology (ESC) Guidelines covers not only the integration of the most recent research, but also the creation of educational tools and implementation programmes for the recommendations. To implement the guidelines, condensed pocket guidelines versions, summary slides, booklets with essential messages, and an electronic version for digital applications (smartphones, etc.) are produced. These versions are abridged and, thus, if needed, one should always refer to the full text version which is freely available on the ESC website. The National Societies of the ESC are encouraged to endorse, translate, and implement the ESC Guidelines. Implementation programmes are needed because it has been shown that the outcome of disease may be favourably influenced by the thorough application of clinical recommendations.

Surveys and registries are needed to verify that real-life daily practice is in keeping with what is recommended in the guidelines, thus completing the loop between clinical research, writing of guidelines, and implementing them into clinical practice.

Implementation Tools

Clinical Algorithm

Foreign Language Translations

Mobile Device Resources

Pocket Guide/Reference Cards

Quick Reference Guides/Physician Guides

Slide Presentation

Staff Training/Competency Material

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

IOM Domain

Effectiveness

Patient-centeredness

Timeliness

Identifying Information and Availability

Bibliographic Source(s)

Task Force on the management of ST-segment elevation acute myocardial infarction of the ESC, Steg PG, James SK, Atar D, Badano LP, Blomstrom-Lundqvist C, Borger MA, Di Mario C, Dickstein K, Ducrocq G, Fernandez-Aviles F, Gershlick AH, Giannuzzi P, Halvorsen S, Huber K, Juni P, Kastrati A, Knuuti J, Lenzen MJ, Mahaffey KW, Valgimigli M, van't Hof A, Widimsky P, Zahger D. ESC guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. Eur Heart J. 2012 Oct;33(20):2569-619. [346

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Guideline Committee

Task Force on the Management of ST-Segment Elevation Acute Myocardial Infarction

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The experts of the writing and reviewing panels filled in declarations of interest forms of all relationships which might be perceived as real or potential sources of conflicts of interest. These forms were compiled into a single file and can be found on the European Society of Cardiology (ESC) Web site   . Any changes in declarations of interest that arise during the writing period must be notified to the ESC and updated.

Guideline Endorser(s)

Association of Cardiologists of Kazakhstan - Professional Association

Belgian Society of Cardiology - Medical Specialty Society

Belorussian Scientific Society of Cardiologists - Medical Specialty Society

Cardiology Society of Serbia - Medical Specialty Society

Croatian Cardiac Society - Medical Specialty Society

Czech Society of Cardiology - Medical Specialty Society

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Spanish Society of Cardiology - Medical Specialty Society

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Turkish Society of Cardiology - Medical Specialty Society

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Van de Werf F, Bax J, Betriu A, Blomstrom-Lundqvist C, Crea F, Falk V, Filippatos G, Fox K, Huber K, Kastrati A, Rosengren A, Steg PG, Tubaro M, Verheugt F, Weidinger F, Weis M, ESC Committee for Practice Guidelines (CPG), Vahanian A, Camm J, De Caterina R, Dean V, Dickstein K, Funck-Brentano C, Hellemans I, Kristensen SD, McGregor K, Sechtem U, Silber S, Tendera M, Widimsky P, Zamorano JL. Management of acute myocardial infarction in patients presenting with persistent ST-segment elevation: the Task Force on the Management of ST-Segment Elevation Acute Myocardial Infarction of the European Society of Cardiology. Eur Heart J 2008 Dec;29(23):2909-45.

Guideline Availability

Electronic copies: Available from the European Society of Cardiology (ESC) Web site [   ]. Also available in Polish [   ] from the ESC Web site.

Print copies: Available from Oxford University Press, Great Clarendon Street, Oxford, OX2 6DP, UK, Tel: +44 (0) 1865 353263, Fax: +44 (0) 1865 353774, Web site: http://www.eurheartj.org/ [   ].

Availability of Companion Documents

The following are available:

- ESC guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. Essential messages. 2012. 9 p. Electronic copies: Available in Portable Document format (PDF) from the European Society of Cardiology (ESC) Web site [   ].
- Acute myocardial infarction in patients presenting with ST-segment elevation. Pocket guidelines. 2012. Available for order from the ESC Web site [   ]. Also available for mobile download from the ESC Web site [   ].
- ESC guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. Slide set. 2012. Electronic copies: Available for registered users from the ESC Web site [   ].

Print copies: Available from Oxford University Press, Great Clarendon Street, Oxford, OX2 6DP, UK, Tel: +44 (0) 1865 353263, Fax: +44 (0) 1865 353774, Web site: http://www.eurheartj.org/ [   ].

Additionally, continuing medication education (CME) credit is available online at the ESC Web site [   ].

Patient Resources

None available

NGC Status

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